Hydraulics & Pneumatics

JULY 1961

EDITORIAL DEPT
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313 NORTH FIRST ST INC
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implify
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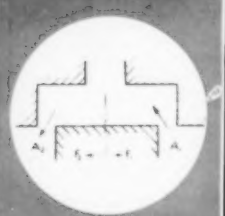
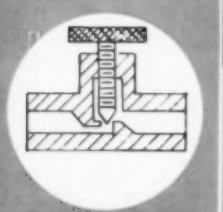
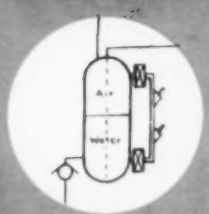
Null-Position Flow Forces in 3-Way Servovalves





A Course in Hydraulic Valves
Part 3-
Flow Controls

Controlling Accumulator Water Level



Spiral-Wrap Hose for High Pressures

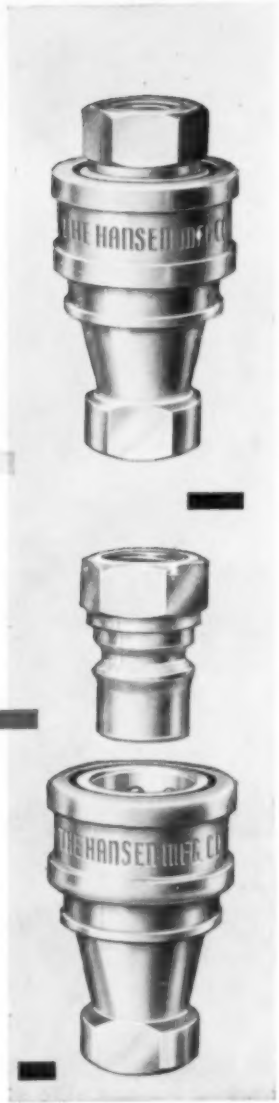
Self-Locking Cylinders Tilt Wings

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

HANSEN

SERIES HK® QUICK-CONNECTIVE

TWO-WAY SHUT-OFF COUPLINGS

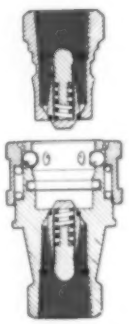


QUICK FLUID LINE CONNECTION OR DISCONNECTION

WITH

INSTANT AUTOMATIC FLOW OR SHUT-OFF

Instantly shuts off both sides of line... prevents loss of liquid, gas or pressure



When Coupling is disconnected, identical valves in both the Socket and Plug provide instant shut-off of gas or liquid. To eliminate leakage or spillage during disconnection, the Coupling is so designed that shut-off takes place *before* the Plug separates from the Socket—and *before* the seal of the Socket itself, provided by the Socket "O" Ring, is broken.

In reverse, when Coupling is connected, the "O" Ring in the Socket completely seals Coupling *before* valves release flow of fluid from both sides of line—thus eliminating possibility of spurt of gas or liquid during instant of connection.

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ACETYLENE • REFRIGERANTS • OXYGEN
OIL • GREASE • COOLANTS • LP-GAS

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Here is an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight Through Couplings.

Representatives in Principal Cities...See Yellow Pages

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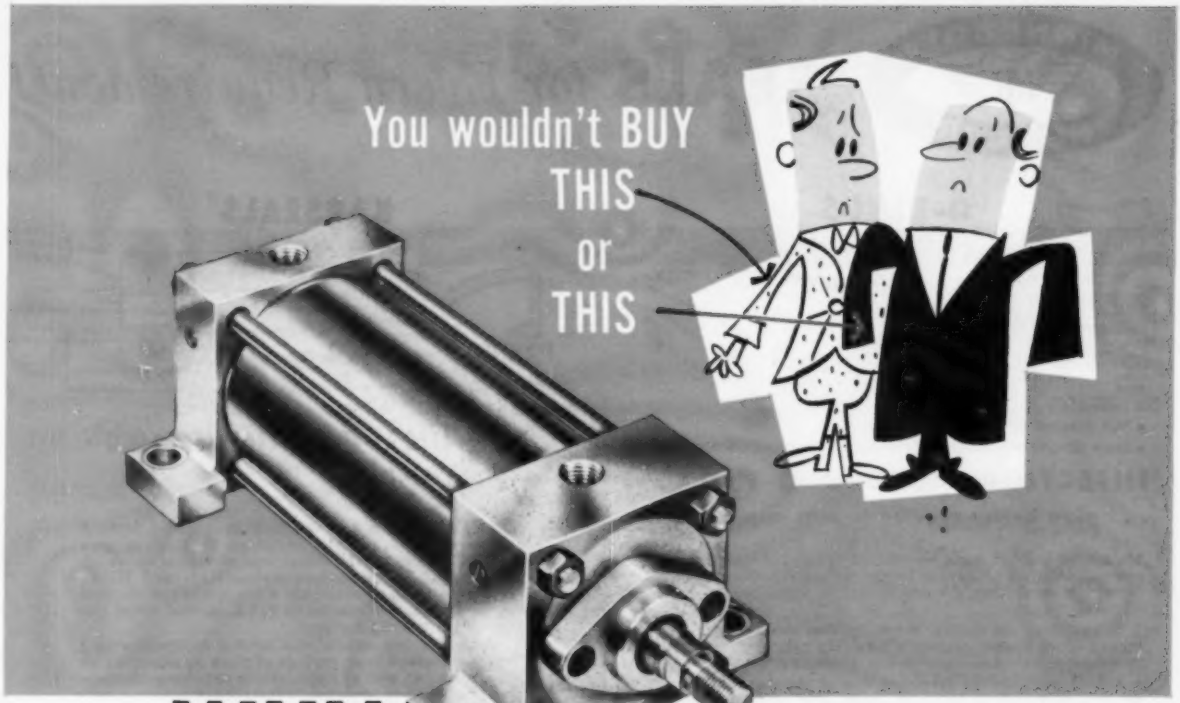

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You'll be glad to know that Hanna Cylinders, custom built to your exact requirements of bore, stroke, mounting, and rod end can be shipped in a time comparable to stock cylinders.

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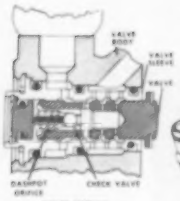

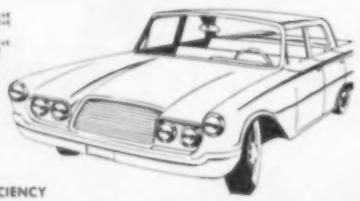

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• HIGH DENSITY • WEAR RESISTANT • CUSTOM COMPOUNDS

INJECTION MOLDED O-RINGS

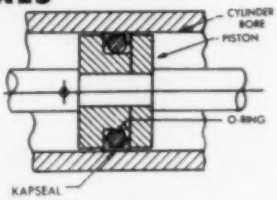
. . . give better service in any application

Minnesota Rubber injection molded O-rings always perform more efficiently and have a longer service life than ordinary O-rings because they do not have any variations in cross-sectional thickness.

In addition, the higher, more uniform density of rubber makes them highly resistant to chemicals and wear due to abrasion.

MR O-rings can be furnished out of the economical, yet durable industrial standard compound 366Y, or if your application requires it, Minnesota Rubber engineers will come up with a customized compound that exactly fits your needs.

KAPSEALS®



LONG LIFE LOW FRICTION SEALING

The KAPSEAL® is a Teflon® boot which is used in combination with a standard O-Ring to give superior sealing performance and eliminate breakout friction. It comes in two styles, KIN and KEX. KIN is used in applications when the ID of the seal is the sealing surface, while KEX is used when the OD is the sealing surface.

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- POSITIVE SEALING UNDER ALL CONDITIONS
- ELIMINATES ALL SPIRAL TWIST FAILURE
- FOUR FLEXIBLE SEALING SURFACES
- LOW FRICTION INSTALLATION
- HIGH DENSITY INJECTION MOLDED
- RUBBER COMPOUNDS TO FIT APPLICATION

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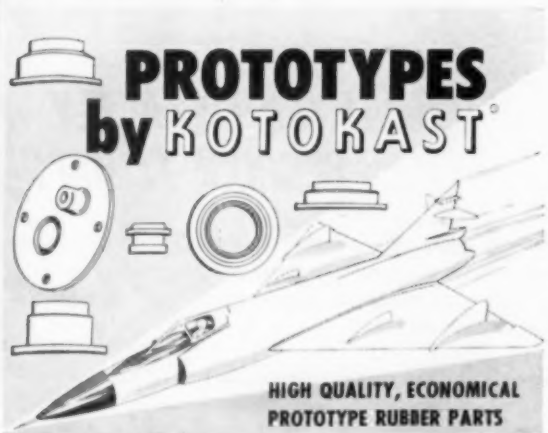

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VOLUME 14/NUMBER 7

JULY 1961

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3000 psi, 8 sizes: 10 gal., 5 gal., 2½ gal., 1 gal., 1 qt., 1 pt., 10 cu. in., 1½ cu. in. 6000 psi, 3 sizes: 10 gal., 5 gal., and 2½ gal. The only type of its design approved under ASME codes of unfired pressure vessels. Approved by Coast Guard and I. C. C. regulatory bodies. Meets J. I. C. regulations.

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In the Hydraulic Hose section are descriptions of Anchor Super-Spiral 4 Ply and 6 Ply Wire Wrap Reinforced High Pressure hose; High Pressure Three Heavy Wire Braid hose; Styles CHX and LHX; High Pressure Two Wire Braid hose, Style C (SAE 100R2); Medium and Low Pressure One Wire Braid hose, Style F (SAE 100R1); Hi-Burst Two Rayon Braid hose (SAE 100R3); Standard Two Rayon Braid hose; Spiral Wire Low Pressure Suction hose (SAE 100R4); and High Pressure Two Wire Braid hose for Non-Flammable Hydraulic Fluids (Phosphate Ester), Style C75.

Anchor Hydraulic Hose Assemblies with Anchor Pressed-On Couplings for unexcelled dependability, longer life and peak performance on virtually all fluid power applications are shown with their respective hose styles.

Anchor Reusable Couplings for high, medium and low pressure use with Two and One Wire Braid Rubber Covered hose; and Hi-Burst and Standard Two Rayon Braid Hose are described. In addition, Anchor Duloc Couplings, for use with Styles QW (SAE 100R5) and Style QWR hose; and Anchor Clamp Type Couplings which attach easily to Wire Braided or Rayon Braid hose are also included.

Anchor Fittings are described and illustrated, and include Adapter Unions, 37° Flare Straight and Angle Adapters and adapter unions; Pipe Fittings; SAE Straight Thread "O" Ring Boss Type Fittings.

Anchor 4-Bolt Split-Flange "O" Ring Head Clamp Type Couplings for use with three wire braid, two wire braid, one wire braid, Hi-Burst two rayon braid, standard two rayon braid, and suction hose spiral wire are pictorially described, with illustrations of available flange stems in straight, 22½°, 30°, 45°, 60°, 67½°, and 90° angles.

Anchor 4-Bolt Split-Flange Pressed-On Hose Assemblies for 4 Ply and 6 Ply Super-Spiral Wire Wrap Reinforced hose, three wire braid, two wire braid, one wire braid, and spiral wire suction hose are also included, together with flange stem styles.

A section on Anchor Freon Hose Assemblies and angle couplings are covered, together with specifications. Anchor Hydraulic Steering and Power Steering Hose Assemblies and Automotive Hose Couplings are also described.

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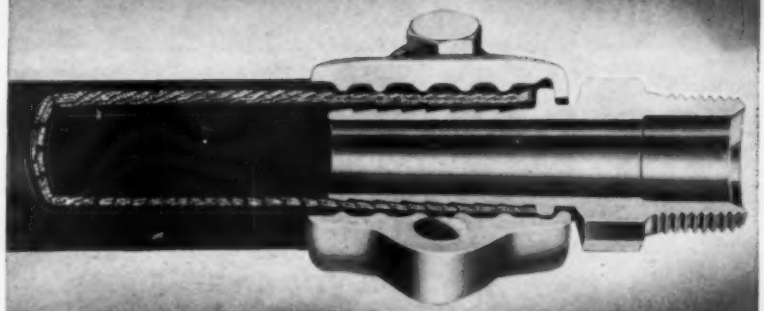

ANCHOR

CLAMP-TYPE REUSABLE COUPLINGS

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TWO AUTOMOTIVE TYPE WRENCHES

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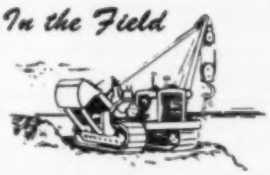
A QUICK, SURE, LEAKPROOF CONNECTION

In the Field



On the Road

In the Shop

Andy Anchor says:

"The Anchor representative who calls on you is a qualified specialist with years of experience in the hydraulic field. He will welcome an opportunity to help you with your hydraulic plumbing problems.

Engineers and operators rely on these easily applied, streamlined Anchor Clamp-Type Couplings for fast, emergency repair and field service, as well as original equipment application.

Designed to accommodate normal variations in hose, they can be applied in the field with no tools other than a pair of automotive-type wrenches, and once applied, provide a sure, safe, leakproof connection that will remain intact up to the burst point of 2 and 3-wire braid hose.

Anchor Clamp-Type Reusable Couplings are supplied in high, medium or low pressure styles, for 3-Wire, 2 Heavy Wire, 2-Wire, 1-Wire, and Hi-Burst 2-Rayon Braid Hose, as well as Spiral Wire Suction Hose.

Write for Catalog No. 304.

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MARVEL

FOR DEPENDABLE PROTECTION

Synclinal SUMP TYPE

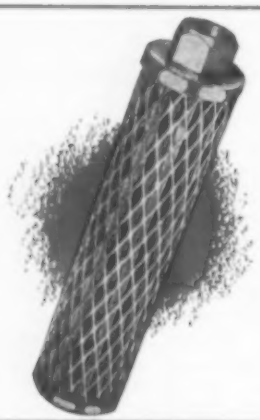
CAPACITIES:
5—8—10—20—30—50—75 and 100 G.P.M.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

CONNECTIONS:
Coupling—Male Nipple.

BY-PASS VALVE:
Not Available.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants, all types of Fire-resistant Hydraulic Fluids and Water.



Tandem Synclinal SUMP TYPE

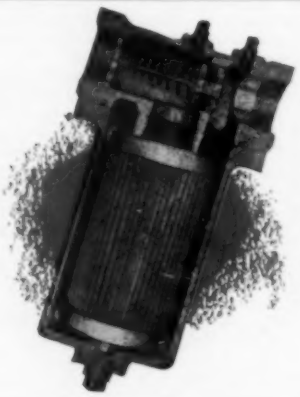
Designed to supply requirements for greater filtering area where installation of two or more single units are not possible due to space limitations in tank.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

CONNECTIONS:
Coupling—Male Nipple.

BY-PASS VALVE Not Available.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids and water.



Bonded SUMP TYPE

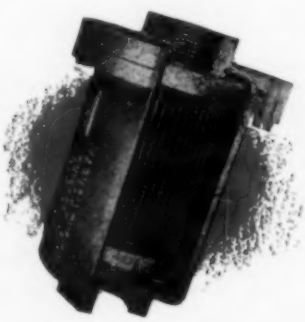
CAPACITIES:
10—20—30—50 and 75 G.P.M.

PIPE SIZES:
1"—1¼"—1½"—2" and 2½".

CONNECTIONS:
Coupling—"O" Ring—Male Nipple.

BY-PASS VALVE:
Available with or without By-Pass Valve.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.



SYNCLINAL FILTERS

on all hydraulic and other low pressure circulating systems

Synclinal LINE TYPE

CAPACITIES:
5—8—10—20—30—50—75 and 100 G.P.M.

PIPE SIZES:
¾"—1"—1¼"—1½"—2"—2½" and 3".

BY-PASS VALVE:
Not available.

OPERATING PRESSURES:
Up to 80 p.s.i.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants, all types of Fire-resistant Hydraulic Fluids and Water.

Bonded LINE TYPE

CAPACITIES:
10—20—30—50 and 75 G.P.M.

PIPE SIZES:
1"—1¼"—1½"—2" and 2½".

MOUNTING BRACKET: All sizes are available with provision for mounting bracket, (also for Flange connection with mounting bracket provisions) if desired.

BY-PASS VALVE:
Available with or without.

OPERATING PRESSURE:
Up to 250 p.s.i.

OPERATING TEMPERATURES:
Up to 300° F.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

IN-LINE FILTER

CAPACITIES:
Up to 60 G.P.M.

PIPE SIZES:
(at both inlet and outlet)
¾"—1"—1¼" and 1½" **NPTF.**
1⁵⁄₁₆-12, 1⅝-12 and 1¾-12 **J.I.C.**

FLANGE CONNECTIONS:
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BY-PASS VALVE:
Available with or without By-Pass Valve.

For use with regular petroleum base Hydraulic Oils, Coolants, Lubricants and all types of Fire-resistant Hydraulic Fluids.

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DEPENDABILITY
EFFICIENCY

QUALITY—All Marvel Synclinal Filters are designed and constructed of the highest quality materials and workmanship to insure maximum protection on all hydraulic and other low pressure circulating systems. *They Meet J. I. C. Standards.*

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EASY MAINTENANCE—All Marvel Synclinal Filters can be cleaned easily and thoroughly "on the spot" in a matter of minutes, resulting in the equivalent of a brand new filter, ready for another long period of efficient and dependable service.

Line type filters operate in any position and may be serviced without disturbing pipe connections.

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Please send me information on Marvel Filters as indicated. AH-7

☐ Sump Type ☐ In-Line ☐ For Hydraulic Oil ☐ For Coolants or Lubricants
☐ Line Type ☐ Tandem ☐ Fire Resistant Fluids ☐ For Water

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hydraulic components reduce replacement time, give longer service!

Whatever the product, installation or application, use Surgepruf hydraulic components if you want the best! Surgepruf Non-Skive Hose and Shur-Lock Reusable Couplings reduce replacement downtime by offering fast, easy, on-the-job replacements. Surgepruf Non-Skive Hose eliminates the need to remove outer rubber cover. Shur-Lock Couplings may be reused by removing old hose and reassembling on a new one. Together they provide one quick, simple assembly without mandrels or special tools.

Surgepruf "Swaged-on" assemblies can be supplied in any dimensions for any application you name! Low, medium, medium-high and high pressure assemblies will be provided to your exact specifications. Each is factory-assembled to speed-up replacement, each will provide the finest leak-proof seal with no braid exposure.

All Surgepruf hose meet SAE Hydraulic Standards for working pressure and burst requirements. Hose temperatures range from −40°F. to plus 275°F. The complete selection of Surgepruf hydraulic components – Shur-Lock and "Swaged-on" assemblies, reusable couplings, hose, adapters and connectors – are available nationally through your local Alemite Company and leading Industrial Distributors.

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... Fluid Power news

OILGEAR 40 Years of Fluid Power

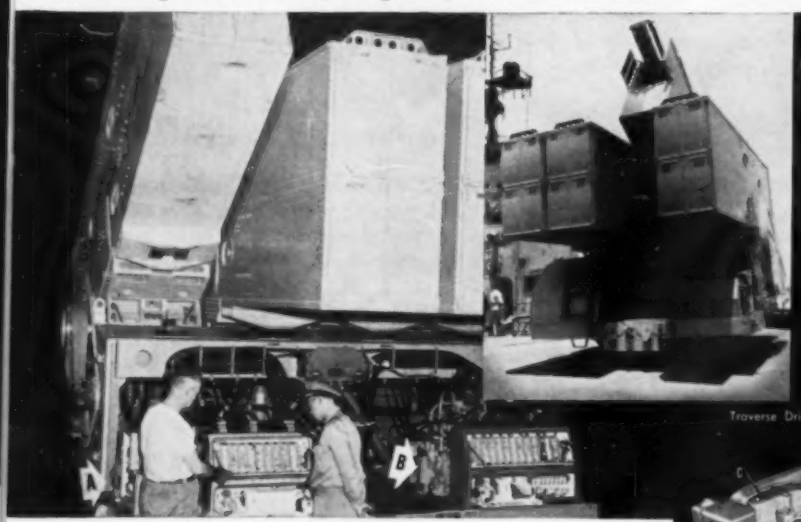
Report No. 11,400 From Oilgear *Application-Engineering* Files

HOW OILGEAR ELECTROHYDRAULIC SERVO-VALVE-CONTROLLED DRIVES AIM *ASROC** MISSILE LAUNCHERS IN RESPONSE TO LOW-POWER SIGNALS FROM SHIPBOARD DIGITAL COMPUTERS.

**ASROC (Anti-Submarine ROCket) — the Navy's deadliest, integrated, anti-submarine weapons system — consists of 4 major parts: an underwater sonar detection device; an electronic, digital, firecontrol (aiming) computer; a "pepper-box" type, 8-missile launcher; and ASROC missiles. Within seconds after sonar detection of a hostile submarine, the computer charts its course, speed, and range — correlated with the ASROC-equipped ship's course, speed, and roll. The resultant computer signals command the launcher to traverse and elevate instantly to accurate "aim" position, and continue to "track" from subsequent computer command signals. The ship commander merely pushes a button to fire either rocket-propelled, homing torpedos or depth charges.*

PROBLEM: Power and control for both the traverse and elevation drive systems to "aim" ASROC missile launchers in response to direct, low-power, electrical command signals from a digital firecontrol computer.

REQUIREMENTS: 1. High traverse and elevation speeds in either direction, with shockless reversal, to bring launcher "on target" — rapidly. 2. Fast, accurate control response for high-speed "homing." 3. Precisely controlled, low variable speeds for "tracking." 4. Entire drive and control systems to occupy a minimum of space within the launcher base. 5. Dependability — "no time-out permitted" — a rigid requirement for fleet use. 6. Unitized assemblies preferred, to facilitate installation and replacement.

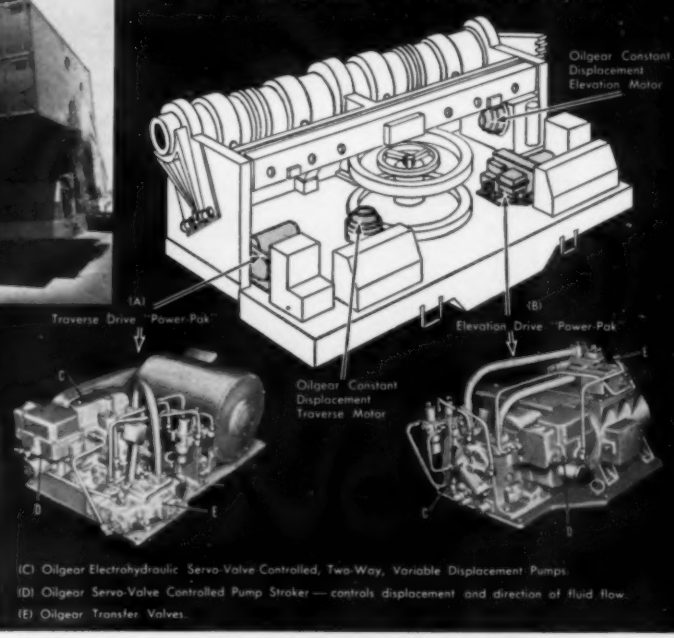


Official Photos — U.S. Navy. Actual launcher performance data is classified information.

ABOVE: ASROC missile launcher being checked at U.S. Naval Ordnance Plant, York, Pennsylvania. Arrows indicate traverse (A) and elevation (B) *Power-Paks*. **INSET:** ASROC launcher ready to fire aboard U.S.S. Norfolk. Each of the 8 cells serve as missile stowage magazines and launchers — all traverse as a unit . . . each over/under pair of cells elevate individually. 360° launcher traverse is possible, but a quadrant is blocked to protect ship's superstructure. Missiles weigh about 1,000 lbs., are about 15 ft long. Launcher base sketch, right, approximates position of Oilgear Drives.

SOLUTION: With Oilgear's experience in meeting the speed, control, and precise turret and gun performance requirements for U.S. Army tanks, howitzers, and anti-aircraft guns — this missile launcher application was a "natural" for Oilgear *ANY-SPEED* Drives — and the alert, accurate response of Oilgear's Electrohydraulic Servo-Valve-Controlled, Two-Way, Variable Displacement Pumps. Amplified signals up to 5-watts actuate drive controls. Cushioned, full-speed drive reversal. These small, rugged, Oilgear *ANY-SPEED* Pump and Motor Drives easily convert output from constant speed electric motors into the exact, required traverse and elevation speeds, direction, and torque . . . even under high overload conditions. An automatic feedback control compensates for load, voltage, or viscosity changes to accurately maintain computer-selected speeds. Torque transmitted automatically increases or decreases to a point just sufficient to overcome resistance. There's no "wire-drawing," or bypassing of fluid to generate heat or waste power. Both systems are totally enclosed, automatically protected against overload, pressure and flood lubricated to assure long, dependable, maintenance-free, service life.

OILGEAR *Application-Engineered* Servo-Controlled Drive Systems for Missile Launchers



(C) Oilgear Electrohydraulic Servo-Valve Controlled, Two-Way, Variable Displacement Pumps.
(D) Oilgear Servo-Valve Controlled Pump Stroker — controls displacement and direction of fluid flow.
(E) Oilgear Transfer Valves.

Oilgear engineering and equipment has solved innumerable "problem drives." Users of Oilgear *ANY-SPEED* Drive and Control Systems in the paper, marine, food, chemical, pharmaceutical, primary metals, metalworking, textile, rubber, and other industries — as well as the military . . . agree that — *"for the lowest-cost-per-year . . . it's OILGEAR!*

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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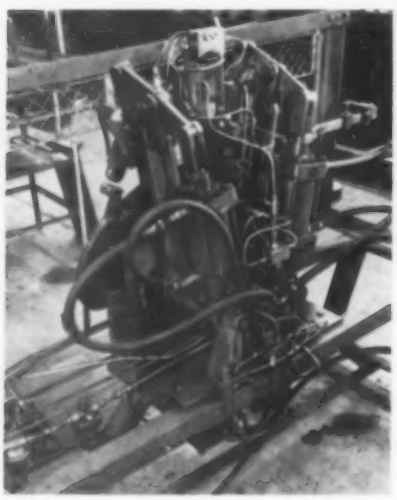
FLUID POWER LINES

from editor to reader

A DESIGN CONCEPT . . . The people at Martonair in England have worked out an analytical approach to circuit design that they call the *Cascade System*, because each sequence is initiated by the preceding one. Although the article on page 65 shows how the system is used to work out a pneumatic system, it's equally useful to design electro-pneumatic, hydraulic, and full electrical systems. The article is based on common components, but the author



points out that further simplifications could be made with special components incorporating several functions.

If you think this is only a theoretical method, the photo illustrates how it has been put to use. It shows a wire forming machine which produces different shapes for holding automobile headlinings.

CLASH OF SYMBOLS . . . If you still have trouble with circuit diagrams using ASA symbols, chances are you don't understand the reasoning behind them. Once you do, you'll probably wonder why you ever spent time drawing symbols that looked like the real component: ports, adjusting knobs, bolts, and all. The article, *How to Read Circuit Diagrams* on page 90 tells what the symbols mean and how you can use them effectively in working out circuits.

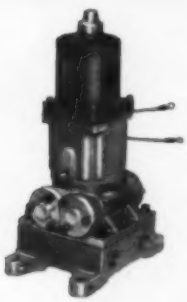
ON THE LEVEL . . . When is a spark plug not a spark plug? Answer: when it's an electrode, sensing water level in a non-separator type accumulator bottle. Many methods have been used to sense water level: magnetic floats, mercury switches, float switches, pressure switches. J. M. Grimstad Co. found a better and simpler way when they mounted an ordinary automotive spark plug in a fitting which connects to the accumulator. A series of these, acting as electrodes, sense water level and actuate the system's pumps or high and low level alarms. The technique is described in *Controlling Accumulator Water Level.*

VALVE FLOW FORCES . . . Fluid rushing through a valve causes unbalanced flow forces. In mobile equipment valves, these forces create a "fifth position" that inhibits the operator's feel. These forces are important in designing servovalves too, because the valve's position depends on a balance of forces. In his article on page 81, Howard Harrison discusses how 3-way valves are affected.

ERA OF VERTICAL FLIGHT . . . Two situations point to the need for aircraft which can take off and land vertically, and fly at speeds to 400 mph. In limited wars, air bases close to the fighting would be an advantage. These would not be suitable for long range transports. With increasing civilian transportation, there will be a need for more, smaller air terminals to supplement large fields far from metropolitan centers. These are the reasons back of the Hiller VTOL development described on page 108. Dating back to 1953, the tilt-wing aircraft has now completed 20 successful flights with wing angles up to 50 degrees.

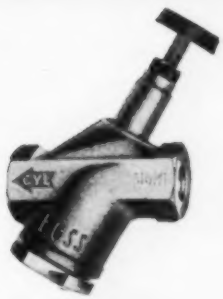
The stock shelves at **Ross** include more different air valves than any other stock shelves in the valve world

Do you know these air controls by Ross?



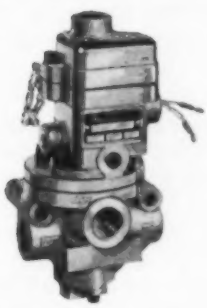
50 Million Cycles in Tests

Ross Goldmodel. A lightning fast, base mounted valve with its solenoid immersed in oil to run cool for long, long life. Full JIC. 3-way, 4-way and 4-way 5 port models. ¼" through 1¼".



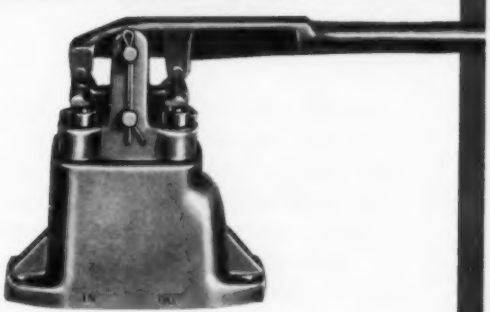
Control Cylinder Speed

Speed Control Valve. The adjustment screw directs air through an orifice that's engineered to give fine shadings of control at either high or low flow rates. ¼" through 1¼".



Does a Big Valve's Work

"Headline Series". Highest capacity valve-size for valve-size of any valve we've seen. Use a smaller, economical inline valve to do a bigger, more expensive valve's work. Fast. S-way, 3-way, 4-way. ¼" through 1½".



Especially for Tough Duty

Ross #100 series. Rough, tough jobs call for this valve which can pass most dirt and foreign matter with no trouble. Few moving parts and short poppet travel makes it especially wear resistant.

FOR OTHER ROSS VALVES SEE SWEET'S PRODUCT DESIGN FILE

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CONSTANT DISPLACEMENT GEAR TYPES WITH ELEVEN DIFFERENT GALLONAGE OUTPUTS... DESIGNED FOR 1000 PSI SERVICE WITH RATED CAPACITIES OF FROM 1.4 TO 47.5 GPM AT 1800 RPM

Precision-built for long, trouble-free service under the most severe operating conditions, they exceed the requirements for a low cost, efficient power source. Highest volumetric and hydraulic efficiency—rugged simplicity—only two moving parts—the impeller assemblies, which roll together with minimum wear and horsepower loss.

- **Pumps operate at higher speeds than most competitive units and permit use of smaller pumps and motors for a given horsepower requirement, thus reducing initial cost.**
- **The unusual drive design of the impeller gear minimizes wear between the gear and end plates. Pumps are self-lubricated. No grease fittings to service and no external drain required.**
- **Special shaft seal assures positive sealing, eliminates packing difficulties. Precision gear type construction makes a quieter operating pump. Ratio of volume output to pump size unusally high.**

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✓ OHIO DRAWN-WELDED is a guaranteed product of Ohio Seamless Tube, SHELBY, OHIO, U. S. A., capital of steel tube production since 1890.

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✓ Check OHIO DRAWN-WELDED on your next tubing order for economy, dimensional accuracy, super finish, strength. You'll see why it's the best buy. A-3167A

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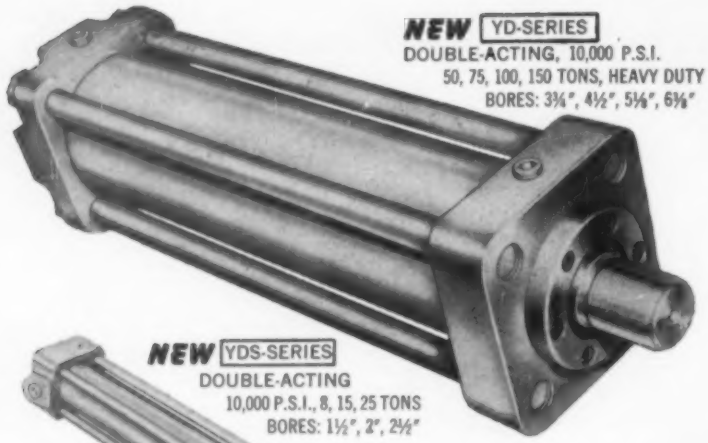
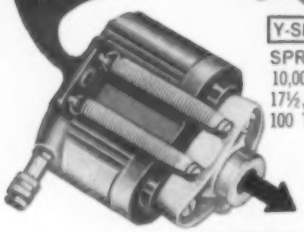


CENTER HOLE

CENTER HOLE



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- THE FIRST ADVANCES FROM OTC'S NEWLY FORMED "PRECISION HYDRAULICS DIVISION"

OTC 10,000 P.S.I. hydraulic cylinders open new possibilities in "hi-pressure" designing by meeting high force requirements with compact, lightweight components. Cylinders are precision built for dependable, continuous performance. Choice of stroke length and standard or tie-rod extension mountings for YD, YDS and YDT series cylinders. Requests for quotations invited.

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LETTERS to the editor

Address your letters to: The Editor, HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Standards for O-ring flanges

TO THE EDITOR:

We are designing equipment including hydraulic lines to 1500-psi oil, in lengths to 300 feet.

We need standards on JIC or SAE O-ring flanges for this type of duty. If you have records of suppliers, or of standards sheets, we would appreciate any information.

WARD E. SQUIRES
Project Engineer
Todd Shipyards Corp.
Seattle Div.
Seattle, Wash.

We have referred you to a manufacturer who makes pipe flanges. Perhaps readers have further suggestions about available standards.

Slipper-type pump

TO THE EDITOR:

With much interest we read your notice about "The Slipper-Type Pump for Automotive Hydraulics", in your issue of October 1960. Is it possible to get more details of this type of hydraulic pump?

LANGEN & CO.
Dusseldorf, West Germany

We suggest that you write directly to Mr. H. M. Clark, Thompson Ramo Wooldridge, Automotive Hydraulics, 34201 Van Dyke, Warren, Mich.

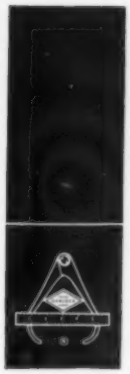
Mr. Clark described this pump in his paper at the National Conference on Industrial Hydraulics, in October.

Fluid Power education

TO THE EDITOR:

While I was overseas on military service, I came across a copy of your magazine. Now back in the U.S., I am interested in fluid

Continued on page 16



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in Design Engineering

Garlock Mechanical Leathers are naturally tougher, offer design advantages not found in other packing materials.

Compare the natural sealing ability of leather packings with various different materials. You'll find a great many advantages not possessed by other well-known types of packings.

In designing hydraulic-pneumatic equipment, you can—for example—benefit from these fine features of leather packings:

- **low coefficient of friction**—less than half of rubber
- **tensile strength**—3000 to 3500 p.s.i.
- **do not score or abrade**—will polish metal surfaces
- **temperature range** from −320°F to +200°F
- **can be stored indefinitely**—exceed government specifications for shelf life
- **pressure range** from vacuum to 100,000 p.s.i.
- **variety of impregnations available,** including wax, plastic, Thiokol† rubber, molybdenum disulfide, and impregnates for special service

Oil (high or low aniline), water or water-oil emulsion, air or gases, fire-resistant phosphate ester fluids and PH Range from 3 to 8 will not harm Garlock leather packings.

In any of three leather tannages—BITAN*, Chrome, or Oak—Garlock can furnish all shapes, sizes, and designs of leather packings. Molded Cups, "U" Packings, "V" Packings, Washers, Gaskets, Discs, Flange or Hat Packings are some of the more commonly specified types. Sizes range from 1/8" O.D. leather washers for needle valves to 99" O.D. "U" Packings for heavy duty hydraulic service.

For more information contact your Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U. S. and Canada. Or, write for Catalog AD-186, Garlock Inc., Palmyra, N. Y.

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Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

†Trademark, Thiokol Chemical Corp. *Registered Trademark

A few words about Couplers from Earl F. Bruning

Fourteen years ago those of us who were most concerned saw that before the art of hydraulics could fulfill its most extravagant promises, there would have to be found a simpler way of connecting fluid lines. It would have to be a precise way, too, because in handling fuels and liquids in the years ahead, no spillage or air inclusion could be acceptable.

At The Bruning Company, we believe we have a family of quick-disconnect couplers that is definitely superior, exhibiting very low flow resistance and turbulence, and with operating pressures from 6,000 to 10,000 P.S.I. and up.

The Bruning line of couplers is the broadest in the industry. Models can be furnished for nearly any fluid medium, ranging from simple hydraulic fluids to the most exotic liquids and fuels—even under extreme temperature conditions.

Types include self-sealing and open-flow, self-locking and slip-joint, and various models for connecting and disconnecting under pressure.

Because we have become specialists in this field and enjoy a remarkable degree of employee cooperation and enthusiasm, we have been able to price most of our couplers substantially below competitive models.

Please let us know your application specifications so that we can send you a sample Bruning coupler.

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LINCOLN, NEBRASKA

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LETTERS

power. Is there any college or technical school in California that has a course in hydraulics? I am specially interested in aircraft hydraulics.

I would also like to know:

- Have you any list of makers of small hydraulic pump-and-motor units?
- Makers of single- and double-acting cylinders.

ALEX BRADFORD
Box 22
Goleta, Calif.

We suggest you contact the colleges and technical schools individually and also the National Fluid Power Association which has made a study of fluid power education. There are very few courses in fluid power, other than Fluid Mechanics, being given.

We are sending sheets from our January issue—listing manufacturers of air and oil cylinders. Most of them make both single and double acting. Makers of aircraft cylinders are indicated. We have also suggested manufacturers of pump-motor units.

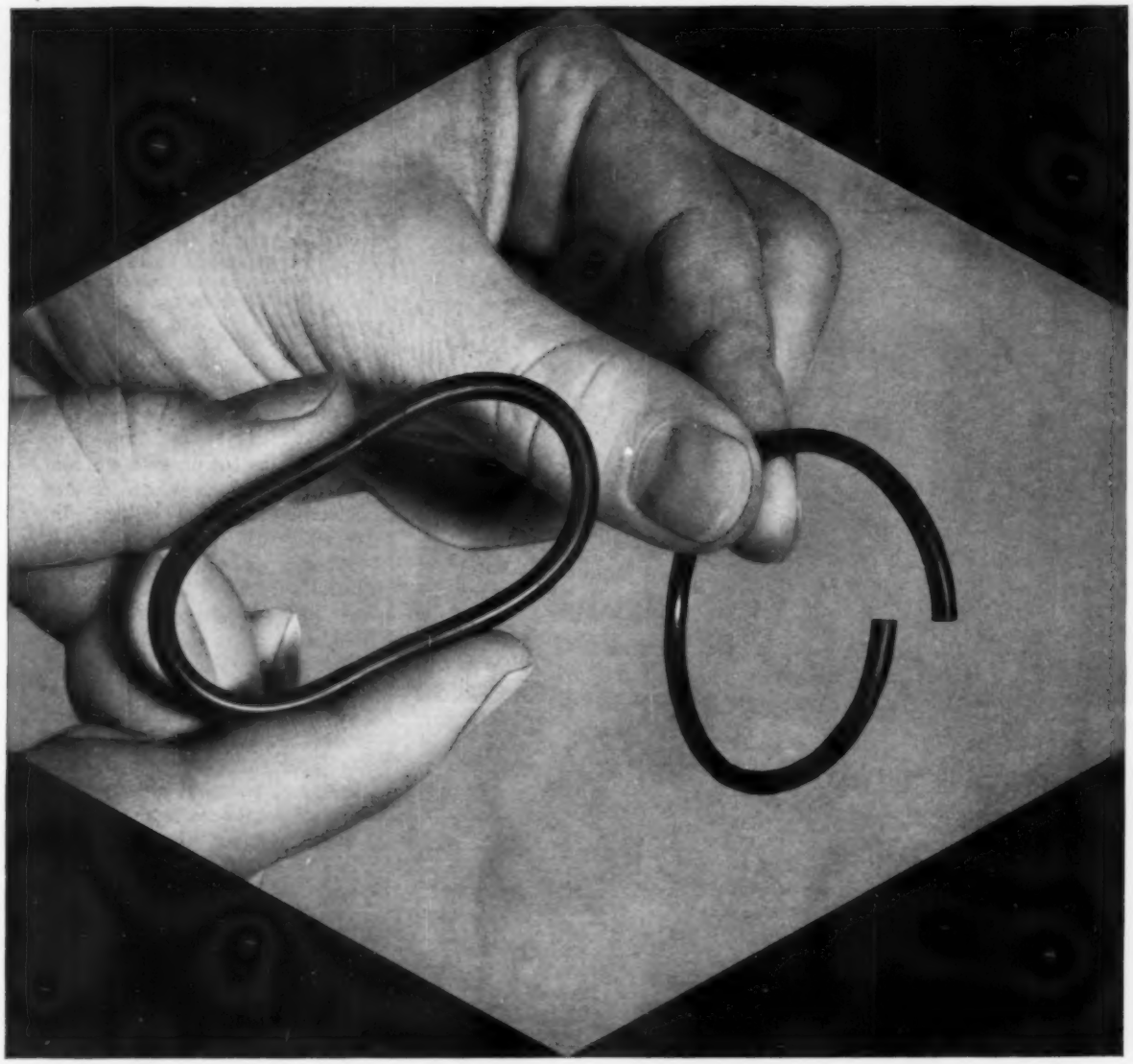
High-pressure, low-flow booster

TO THE EDITOR:

We want a very small hydraulic pump, to be used on a rig for testing pressure gauges. The gauges are tested on pulsating pressure up to 4 cps. Maximum delivery of ¼ gpm is all that is required at over 5600 psi, which is the pressure of the pump which we have, or at 16,000 psi, which is the pressure we would like. Air intensifiers are made in this country, but their volumes are insufficient for our purpose.

C. R. A. GRANT
Governing Director
Barnet Instruments, Ltd., Technical Div.
The Bury, Codicote, Hitchin,
Hertfordshire, England

To do pressure testing up to 16,000 psi, you're probably going to have to use some type of intensifier similar to the one which you mention. Names of booster manufacturers have been sent. ▼▼▼



Reduce loss from leakage due to brittle seals, cut downtime needed for seal replacement. Extend the life of your Buna N and neoprene packings and seals with quality Sun Solnus oils. In a special test for oil-seal compatibility, Sunoco researchers immersed a set of O-rings in Sun Solnus oil, and a second set in another hydraulic oil, for 70 hours at 300 F each. The O-rings in the Solnus oil (*above, left*) retained their flexibility. Other rings (*right*) turned brittle as the oil robbed the rubber of its plasticizers. In addition to keeping rings flexible, Solnus oil restores flexibility to brittle rings already in service.

SUNOCO keeps seals from snapping!

SUNOCO

Quality . . .

THE BEST ECONOMY OF ALL

Sun Solnus oils provide the exact qualities you want in good hydraulic oils, including extended life of your packings. They're job-fitted by men who know what the job entails . . . backed by the service you have a right to expect. See your Sunoco man . . . or write to Sun Oil Company, Phila. 3, Pa., Dept. AH-7 In Canada: Sun Oil Company Limited, Toronto and Montreal.

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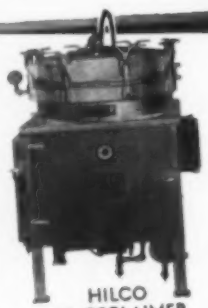
- No More Accumulation of Dirt

Filter life up to a year eliminates usual frequent draining, refilling of systems.

HILCO Hyflow Oil Filters trap dirt, acids, rust, sludge, gums, resins . . . all solid contaminants, and keeps your hydraulic system clean and in top running condition at all times. To you, this means longer oil life, reduced wear and abrasion . . . hence, less down time and lower maintenance costs giving you continuous equipment operation with increased production. Hydraulic unit sensitivity depends upon a clean system. HILCO Hyflow filters remove solids as soon as they enter the system and retain much of the moisture which enters the oil from the atmosphere and from condensation. Obtain the full capacity and economy of your equipment by keeping it in top running condition with HILCO. Hydraulic Oil Filters come in stationary or portable models. They can be hooked into hydraulic systems without interrupting equipment operation.



HILCO OIL RECLAIMER

For complete oil reclaiming. Removes solids, acids and volatile impurities; moisture, solvents, gasses, etc., from hydraulic fluids by heat-vacuum process.

• SEE FOR YOURSELF HOW HILCO keeps your Hydraulic System Clean . .

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FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

• What improvements would you like to see in fluid power components?

So far as components are concerned, everyone wants greater reliability and less leakage. Increasing use of exotic liquids makes it difficult for component manufacturers. It isn't good practice to make components compatible with all fluids. We should stick to one problem at a time. Design the components for a single service and stick to it. Then make it the best for that service.

Higher pressures are a must. New seal materials are becoming available to permit higher pressures, especially where non-exotic fluids are used. One particular seal material to make big news this year is solid polyurethane elastomer. It will definitely be a breakthrough in certain high pressure applications.

DENNIS APPLETON
Engineer
Appleton Engineering Co.
Woodmere, New York

The big need in aircraft hydraulics is for dynamic seals for translating motion in high-temperature systems (400 F and up), yet suitable at —65 F also.

R. ASHBY
Design Engineer
The Bendix Corporation
North Hollywood, Calif.

We are distributors of fluid power components. Our customers have made a number of suggestions for improving currently available fittings.

High pressure, flared tube fitting are often requested by AN numbers. There are a number of

Continued on page 20

Another Example of "EnginAlRing" by Modernair

COMPACT CONTROL VALVES

FEATURING

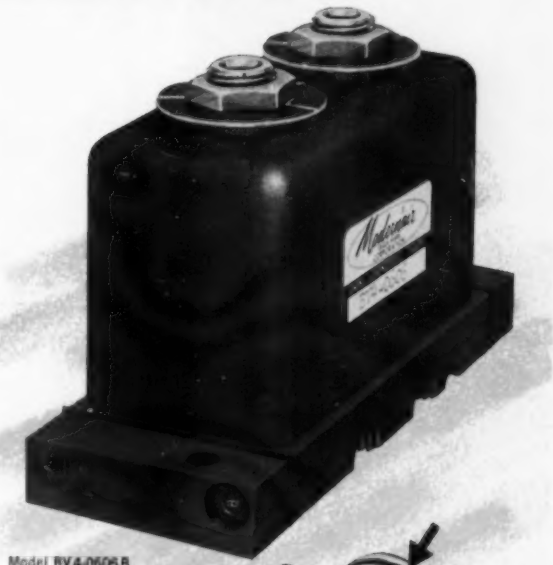
Moly-Impregnated

"O" RING SEALS

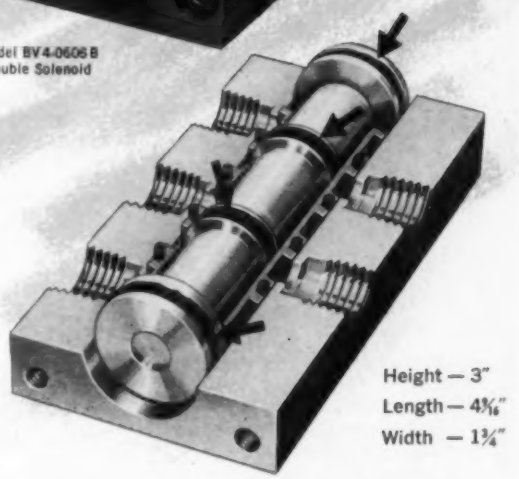
ONE BIG PROBLEM with miniaturized pilot pressure-operated control valves of sliding spool design has been the "o" ring sealing. Seals adequate to hold up to 200 psi line pressures created too much friction for reliable spool shifting at low (20 psi) pilot pressures.

THE SOLUTION is moly-impregnated "o" rings. The addition of small amounts of molybdenum to conventional "o" ring molding compounds creates an astonishing self-lubricating effect. Moly-impregnated "o" rings seal most effectively, yet offer almost negligible friction. The result is a tight, tiny little valve that requires just a breath of pilot air to control line pressures to 200 psi.

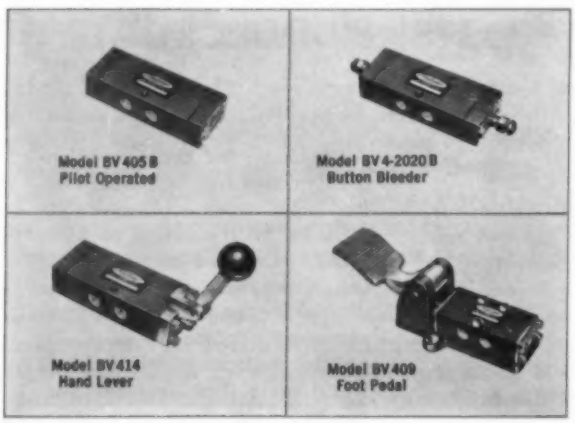
This exclusive Modernair development means that you can design compact, lightweight low-pressure systems to control even the biggest fluid power actuators.



Model BV4-0606B
Double Solenoid



Height — 3"
Length — 4 5/16"
Width — 1 3/4"



It's an example, too, of Modernair's "EnginAlRing"—a continuing policy of bringing you greater value through product improvement, at no increase in cost. Prices on the improved valves shown here are exactly what they were in 1958!

For better value all down the fluid power line, why not check Modernair's complete 1961 catalog of cylinders, valves and accessories? For your free copy, write us or call your nearest Modernair Sales and Service Dealer (see your phone book yellow pages).

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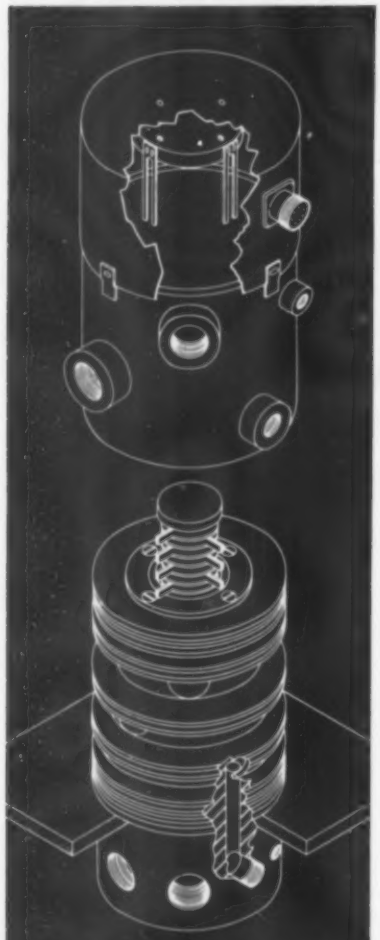
Circle 106 on Reader Service Card

IMAGINATION FOR SALE!



CIRCLE OF POWER

UH-designed swivel assures a "circle of power" for an aerial lift by carrying two high pressure hydraulic lines, tank line, air line, and seven electrical lines from base to rotating superstructure. Operator in aerial bucket has complete freedom and flexibility of movement, can rotate 360° continuously. Some machines have only limited rotation in either direction. Whether your hydraulic problem is complex or commonplace . . . call or write UH today.

UNIVERSAL HYDRAULICS

DIVISION OF HOLAN CORPORATION
4500 BEIDLER ROAD
WILLOUGHBY, OHIO
PHONE: 946-2100

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FORUM

AN items, particularly reducing unions, that are not available from some the major industrial fitting manufacturers. Our customers would like to have a greater variety of fitting configurations available to them.

In the high pressure, flareless type fitting, it is possible to assemble some fittings with the sleeve in backwards. This causes trouble including the loss of expensive hydraulic fluids. Why isn't there a fitting with a sleeve which can be inserted either way into the tube nut without danger?

G. AVON, JR.
Manager
Ronval Industrial Supply
Mishawaka, Indiana

Higher efficiency, smaller size, lighter weight, longer life at all temperatures is what we need in hydraulic pumps and motors. Since our applications are almost entirely aircraft, missiles, and air transportable equipment, all of the above factors are critical.

V. SIMBULAN
Senior Engineer
Stewart-Warner Corp.
Indianapolis, Ind.

Hydraulically speaking, our chief preoccupation at New York Shipbuilding is with nuclear submarine plants. Therefore, our pumping problems are threefold. In descending order of importance they are: reliability, noise, and size and weight.

Since the hydraulic system furnishes the brawn for the submarine, it is imperative that we make these muscles as completely dependable as we can. This means that we must improve the reliability of all system components, including, of course, pumps and motors.

To a great extent, the effectiveness of the submarine is measured by its ability to remain undetected. Indeed, her very life may depend upon it. Therefore, we require quieter pumps and motors. In this area of pump development lies the greatest opportunity for improvement, particularly in the reduction of structure-borne noise.

The advantages of size and weight reduction are obvious. Less weight means more speed and greater maneuverability. Smaller size means more room for payload or other vital gear.

We have achieved a delicately balanced compromise wherein reliability, quietness, and compactness have been combined to an optimum degree. We cannot, generally speaking, degrade either of the other two characteristics for the sake of improvement in the third. For example, we cannot improve noise characteristics at the expense of reliability. Nor could we tolerate a lighter, more compact pump which generated substantially more noise. Essentially, we want to eat our cake and have it too. We're looking for quieter more reliable pumps and motors in lighter more compact packages.

G. E. KREJCI
Design Engineer
New York Shipbuilding Corp.
Camden, New Jersey

There has been quite a bit of agitation for the use of silicone oil instead of silicate esters in airborne military equipment both for cooling and for hydraulic systems. The lack of lubricity of silicone oil is tough on wearing parts, and on both static and dynamic seals.

C. STEMMER
Process Design Engineer
General Electric Company
Utica, New York

Pneumatic and hydraulic valves could be improved by making them less complicated and easier to work on. I have worked on some foreign valves that are simpler and less precise than ours, and yet give the same results. If American valves were made as simple as possible with close tolerances, it would make them easy to maintain and troubleshoot.

Make valves so that they are interchangeable with other company's valves, unless they are for a particular application. If valves of standard useage were interchangeable, there would be no

Continued on page 22

Circle 88

Caterpillar selects Koppers piston and sealing rings for use in the world's largest single engine crawler tractor.

A brute of a tractor for brute force jobs, Caterpillar's D9 Series E Tractor applies a 335 HP engine which combines the versatility and economy of diesel power with the power boosting efficiency of a turbocharger. Traditional Caterpillar durability is built into every part. And in the power shift transmission sealing rings, chrome plated malleable iron compression rings, crankshaft seals, and steering control seals, that durability spells K-O-P-P-E-R-S.

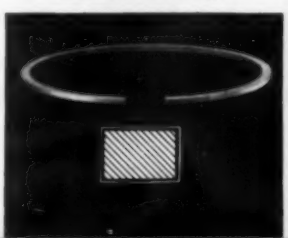
Says Caterpillar: "The D9 Tractor is ruggedly built for long life under the most severe operating conditions. In addition, special attention has been given to insure the production of a power plant that is easy and economical to operate and maintain. On all these counts, the Koppers rings and seals we have selected meet our requirements of quality and dependability."

Write today for 8 page brochure on metallic sealing rings to: KOPPERS COMPANY, INC., Piston and Sealing Ring Department, 6007 Hamburg Street, Baltimore 3, Maryland.

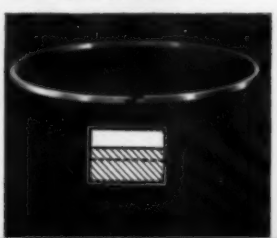
CRANKSHAFT SEALS: Application of a conformable step seal ring (specially designed for Caterpillar) establishes a *permanent* crankshaft seal, reliable for the life of the engine.

TRANSMISSION SEALING RINGS: Specially designed metallic sealing rings transmit fluid power to the rotor and actuate the clutches of Caterpillar's dramatic new power shift transmission.

COMPRESSION RINGS: Dependable performance at the most critical point in the combustion chamber is assured by chrome plated malleable iron rings.



STEERING CONTROL SEALS: Caterpillar's new design steering control requires a rotating, high pressure seal. Piston ring type seals establish simplicity, reliability.



KOPPERS

PISTON & SEALING RINGS

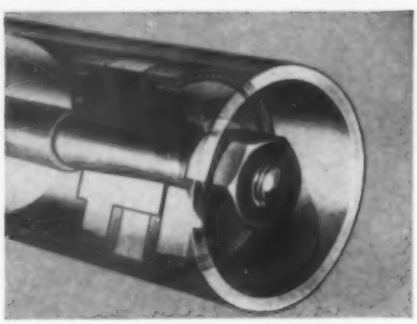
Engineered Products Sold with *Service*

PUMCUPS

outlast ordinary packings

3 TO 1

- *in hydraulic and pneumatic mechanisms*
- *in reciprocating pumps*



With Darcova Pumcups...regardless of wear, pressure keeps Pumcups hugging cylinder wall.

Operating costs go down and efficiency goes up when Darcova Pumcups go in! Here's why:

- **Pumcups outlast other packings at least 3 to 1, based on actual reports from users**
- **Fluid slippage is virtually eliminated, because Pumcups operate at full efficiency throughout their entire life**
- **Maintenance costs are reduced, because you have fewer replacements, less downtime.**

Available in three textures—hard, medium and soft. Also in regular or 100% nylon composition. Size ranges from ¾" to 20". For *all* the facts on Darcova Pumcups, write for Bulletin 5903.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

TRADE MARK
PUMCUPS

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FORUM

problem on spare parts or service. If one company did not have parts, you could always go to another. In this way the valve companies do not have you depending on them, and they would not be so independent. Of course, this would not apply to valves made for a particular application.

Also I suggest having a board or independent laboratory to test valves and pumps, to make sure they perform as advertised. This group could be called upon for information regarding pumps and valves. In this way you will not have to depend on what salesmen tell you. We have run into this problem many times in the past, changing from one company to another and then finding that the unit does not live up to what it is supposed to.

D. HUFSEY
Hydraulic Engineer
Wheaton Plastics Co.
Mays Landing, New Jersey

I would like to see hydraulic manufacturers standardize on some type of flanged connections for hose, pipe, and tubing for larger size units. I think all hydraulic equipment manufacturers should improve their service facilities and the quality of their equipment before it leaves their plants. Then field corrections will not have to be made.

F. O'CONNER
Chief Engineer
American Machine & Metals Corp.
Tolhurst Centrifugal Div.
East Moline, Illinois

Contamination requirements have virtually eliminated all but 300-series SS with fluoro compounds for seals and hoses. Only one or two companies have made any effort to manufacture components other than valves and fittings. There is a need for accumulators, pumps to 2 gpm at 4500 psi, and other components.

Z. CHAPMAN
Design Engineer
Lockheed Missile & Space Div.
Sunnyvale, California

▼▼▼

Circle **145** →

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LARGE CAPACITY FOR WATER—AIR—STEAM NO. 127
SMALL PRECISION FOR AIR NO. 15
GENERAL PURPOSE FOR AIR NO. 112
HIGH CAPACITY FOR AIR NO. 18
SELF-CONTAINED FOR STEAM NO. 152
LOW PRESSURE FOR AIR NO. 115
GAS REGULATOR FOR LP & ACETYLENE NO. 6
LARGE VOLUME FOR WATER NO. 135
ALL PURPOSE FOR WATER NO. N26

NOW! MATCH THE PRESSURE REGULATOR TO THE JOB

LARGE . . . SMALL . . . FOR REGULATING AIR, STEAM, WATER, LP GAS, ACETYLENE, AND SOME OILS — Watts has the right pressure regulator to control them all precisely.

Watts pressure regulators are compact, designed for the job. No jury-rigging needed. Nor do you have to settle for a bulky, high-priced regulator designed for an entirely different application.

And they're **sensitive**—they detect minute variations in flow rate, control them accurately with minimum pressure drop, yet offer maximum flow capacity.

There's a complete line of regulators for air, ranging from ⅛" to 1", with or without gauges. Conveniently-located Watts distributors **ship from stock** on receipt of your order.
WRITE FOR FREE TECHNICAL CATALOG.

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FILTERS
REGULATORS
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YOUR SAFE SPECIFICATION

Watts Regulator Company, Industrial Division, Lawrence, Mass.

ROPER PUMPS

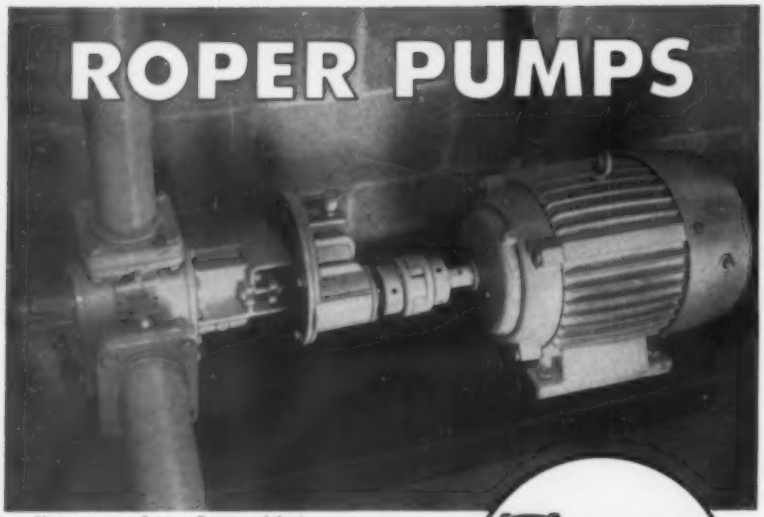
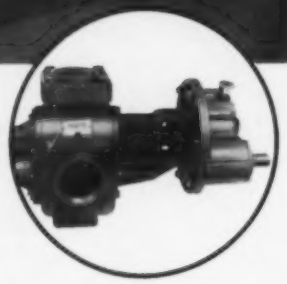


Photo courtesy Custom Canners, Atlanta



SERIES 3600 MAHBRV #4

supply high viscosity liquid sugar in canned soft drink operations

• **OUTPUT CAPACITY: 40-300 GPM** • **PRESSURES TO 100 PSI**

The Potter & Rayfield liquid sugar system installed for Custom Canners, Inc., producers of canned soft drinks, uses Roper Series 3600 MAHBRV #4 as the pumping component. Specification of a Roper unit for the system was made to handle the 10,000 SSU viscosity of the 50% inverted liquid sugar at 60°F, and lower, temperatures. The installation requires consistent output at slow pump speeds. Batch-type production means intermittent pump service, but the unit still handles some 1500-3000 gallons per day. In addition, unloading, transfer to storage, and movement of syrup to mixing vats are handled by the Roper pump, which is connected to a 1800 rpm, 7½ hp motor. Standard, specially modified, and custom Roper units serve original equipment in a wide range of industries — marine, process, chemical and petroleum. A Roper can serve the needs of your equipment also.

Balanced Construction — Reliable Production

- **Axial Hydraulic Balance** of the gears provides vibration-free operation, smooth, pulsation-free output.
- **Gear Construction** includes special machining for tooth forms to insure correct meshing and efficient displacement.
- **Induction Hardening** of steel shaft at bearing and packing surfaces means longer, maintenance-free service.
- **Four High-Lead Bronze** or chrome-iron bearings give balanced support and maintain proper alignment for the helical-type pumping gears. Sleeve bearings are heavy-duty bronze.

For information about your specific pump needs contact your nearest Roper dealer

Send for new 16-page Series 3600 catalog

ROPER HYDRAULICS, INC.

Dependable pumps since 1857

COMMERCE, GEORGIA

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FUTURE EVENTS

WESTERN PLANT MAINTENANCE SHOW

July 18-20

Pan Pacific Auditorium
Los Angeles

ASTM MEETING ON AEROSPACE HYDRAULIC FLUIDS

Aerospace Applications for Hydraulic Fluids & Test Methods, Technical Committee N, Committee D-2

August 2-4

SantaYnez Inn
Pacific Palisades, Calif.

For further information, contact M. L. Fickel, c/o Maledco Engineering Corp., 731 West Wilson Ave., Glendale 3, Calif.

1961 CRYOGENIC ENGINEERING CONFERENCE

August 15-17

Univ. of Michigan
Ann Arbor

SAE PRODUCTION FORUM & ENGINEERING DISPLAY

Combined SAE Farm, Construction, and Industrial Machinery; Power Plant; and Transportation Meetings.

September 11-14

Milwaukee Auditorium

SAE A-6 COMMITTEE MEETING

Aerospace Hydraulic & Pneumatic Systems & Equipment.

Week of September 25

Ramada Inn
Phoenix

SAE AEROSPACE ENGINEERING & MANUFACTURING MEETING

October 9-13

The Ambassador
Los Angeles

FLUID POWER SOCIETY ANNUAL MEETING

October 18

Sherman Hotel
Chicago

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

October 19-20

Sherman Hotel
Chicago

NFPA FALL MEETING

October 24-26

Sheraton Hotel
Philadelphia

Circle **103** →

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Miller

You can use Boosters to particular advantage in:

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For prompt personal service, call our Engineering Dept. at Porter 6-3400 Bensenville, Ill. Call "collect," person to person (at our expense).

Exactly how do Boosters save space, weight, air, cut costs, increase efficiency, reduce maintenance? How do they provide smooth hydraulic power (up to 10,000 psi or more) from your shop air and maintain pressure without heat generation or additional power consumption? Exactly how and where are they now being used? The whole absorbing story is told in color—along with full information on available models, dimensional data, pricing, etc.—in this new interesting booklet specially prepared for busy, time-short designers, engineers, and production men. *Write today for your free copy.*

R

MILLER FLUID POWER

DIVISION OF FLICK-REEDY CORPORATION

7N017 York Road, Bensenville, Illinois

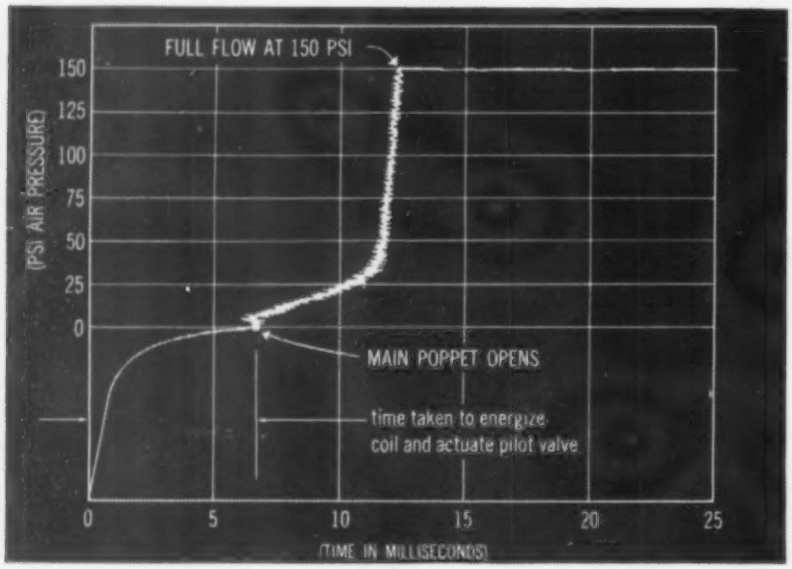
AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

'Mach 2' Air Valve Gives 12 Millisecond Response

Oscilloscope tracks valve action from 0 to full flow at 150 psi

Twelve milliseconds is the time required to energize the solenoid coil, actuate the pilot valve, and bring the main poppet of a "Mach 2" air valve into fully open position at 150 psi. To record the instant response that eliminates lag in air-automated operations, a Crescent® "Mach 2" 4-way air valve was tested by the American Laboratory, Los Angeles, California. A camera located over the oscilloscope screen (Fig. 1) photographed the response action. Tests were made with a 12 volt DC coil in the de-energized position, poppet No. 1 in the closed position, and a system pressure of 150 psi. The graph (Fig. 2) was drawn from a photograph of the oscilloscope screen. The curved line in the lower section of the graph indicates the time required to energize the coil and actuate the pilot valve. The heavier line, above, is the oscilloscope's registration of the increase in pressure as poppet No. 1 moved from closed position to full open position where 150 psi line pressure was reached. Total elapsed time is 12 milliseconds.

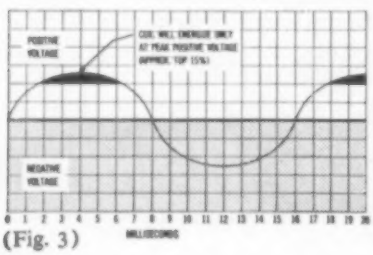
(Fig. 1)



(Fig. 2)

Corresponding results on AC current

Tests were run, also, on AC voltages and identical fast response was registered when coil actuation began at the positive peak of the AC sine wave. As indicated in Fig. 3, a wave length of AC current is approximately 16 milliseconds in duration. A coil will not energize until voltage has reached approximately 85% of capacity. The energized period represents 15% of the sine wave or 4 milliseconds. Therefore, additional milliseconds will be added to response time up to 12 milliseconds if the peak of the sine wave is not caught. Thus, the response time of a "Mach 2" air valve on AC voltage is from 12 to 24 milliseconds. This fast action is positive assurance against lag in operations where instant response is imperative – sorting, counting, discarding sub-weight containers, spot welding, etc.



(Fig. 3)

High speed PLUS dependability

The fast response of "Mach 2" air valves is attributable to original design advances that also dramatically improve endurance. These new air valves are rated at 1000 cpm continuous duty, and cycling speeds to 2100 cpm have been maintained for intermittent periods of 20 minutes. Control of coil heating and drastic reduction of friction in the solenoid and pilot valve sections are essential for this kind of performance. The extremely short stroke of the "Mach 2" solenoid plunger (3/32" – approximately the thickness of a nickel) fractions the time the coil is energized; heat generation drops and response is stepped up. Coil life is guaranteed for a minimum of 100 million cycles.

Friction drastically reduced

In the pilot valve, a tiny ball seats on "O" rings at both ends of a pilot cartridge. The ball moves freely, independent of the seals. There is no "O" ring drag on the pilot plunger because it requires no seals; where there is no friction there can be no wear. The main valve seats seal on "O" rings, and metal shoulders take the shock in such a way that the "O" ring seal is merely kissed by the seat in the sealed position. As the rings are only minutely flexed, they do not fatigue or lose their resilience.

PILOT CARTRIDGE

Write for your "Mach 2" catalog

The 12 millisecond response and long service life of "Mach 2" pilot operated air valves are sound recommendations for the installation of these field proven units. They are available in ¼" to ¾" pipe sizes. For your "Mach 2" catalog write to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, California.

"Mach 2" 4-Way Valve

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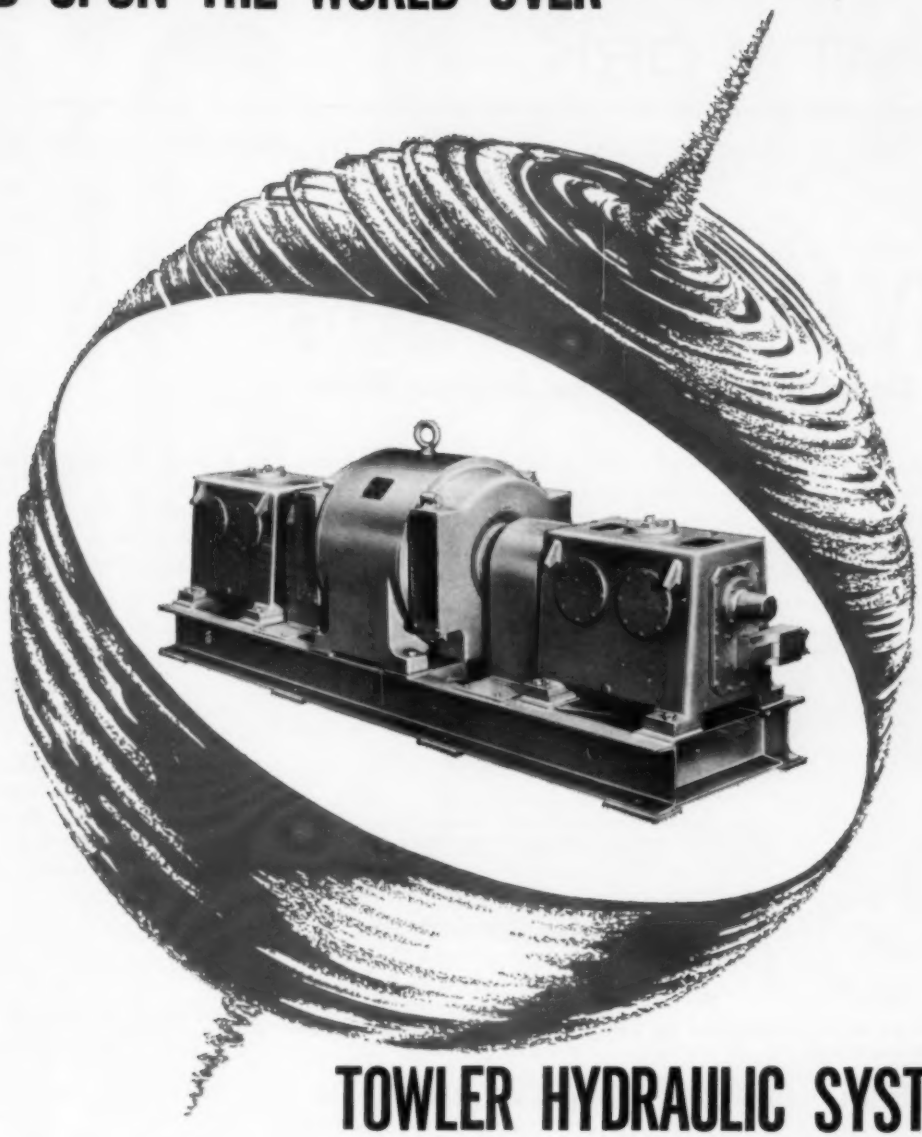
RELIED UPON THE WORLD OVER



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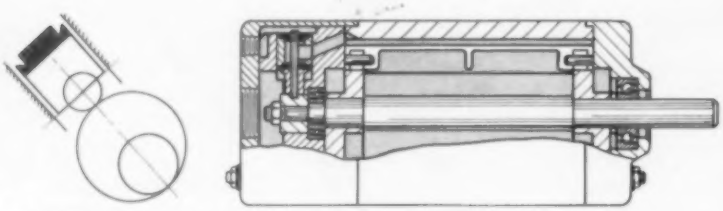
FLUID POWER AT WORK

keeping up with design, application, methods

New Developments at the Design Show

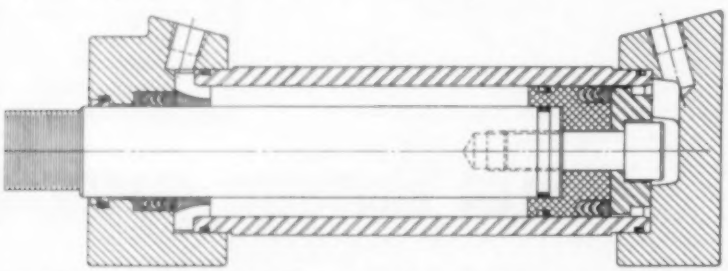
Under the polished covers and fresh painted housings of new products shown at the Design Show in Detroit were some fascinating new design concepts. Here are some that intrigued H&P editors.

• **High Torque Air Motor**—Five elongated pistons which drive through eccentrics on the output shaft are part of Humphrey Products' new air motor design for low air consumption, high starting torque, and low inertia. Valves for the pistons are timed by a cam. By eliminating connecting rods and using aluminum pistons with only $\frac{5}{8}$-in travel, inertia is kept low. The motor requires 20 cfm per hp, has 14 lb-ft starting torque, and can run at speeds to 5000 rpm. Six sizes range from 3 through 24 hp.



AIR MOTOR'S five elongated pistons are arranged radially and drive against eccentrics on the output shaft.

• **10,000-psi Cylinders**—Among components for very high pressures shown by Owatonna Tool were cylinders with bore sizes of 1½, 2, and 2½ inches. The design shown has a metallic rod wiper-scraper, heat-treated alloy steel piston rod which is ground and polished to 10-15 micro inch finish, and heavy wall cylinder shell bored and honed to 10-15 micro inch finish. A twin cylinder design with a threaded center hole permits running a rod or cable through the center between cylinders.



10,000 PSI TIE ROD CYLINDER seals with V-Rings on the rod and cylinder. Push capacities are 8, 15, and 25 tons with 1½, 2, and 2½-in. bores.

• **Seal Developments**—Among products exhibited by International Packings were rubber cups with a Rulon (filled Teflon) covering. This gives better wear with lower friction.

• **Plastic Magnets**—Using barium ferrites impregnated in plastic, Lisle Corp. has designed very compact magnets for installation in small hydraulic tanks, such as those on mobile equipment. In the design shown, the back plate forms the north pole and each magnet strip forms south poles

END VIEW OF MAGNET ASSEMBLY shows how plastic magnets can be assembled in compact package.

giving a long magnetic field for chip collection. In another development, Lisle has applied an electrical indicator circuit which detects when a magnet needs cleaning. Air gaps vary from .008 to .313 in. depending on size of chips to be collected. This is being used with constant speed drives and hydraulic test cells.

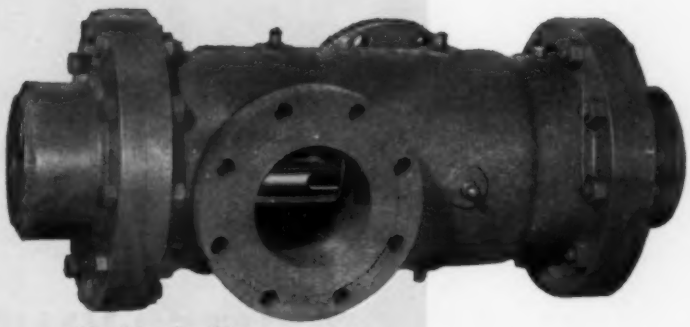
• **Brazed Fittings**—For high temperatures and pressures, Imperial-Eastman showed a new brazed fitting which is easily disconnected. It has a sleeve which is slipped over the tube end and brazed with a silver brazing ring. A nut which has been previously

Continued on page 30

BIG CONTROL VALVES

up to 8 in. • 5000 psi

2 in., 3-way 3-position, double solenoid type.



8 in., 2-way 2-position, double pilot cylinder type.

Need more flow capacity than you can get with the largest sizes available in most valve lines? There's an easier answer than resorting to costly multiple valving, or redesigning your system to suit flow limitations.

Hunt builds valves in sizes up to 8 in., with air flow ratings of *more than 32,000 cfm* @ 100 psi pressure drop! In fact, you can choose from valves ranging in size from ⅛ through 8 in.; 2 and 3-way, 4-way 2 or 3-position; solenoid, remote-pilot or mechanically actuated; with a variety of optional mountings and features.

If control of large volumes of air, oil, water, or soluble oil and water at pressures up to 5000 psi hyd. is one of your requirements, it'll pay you to talk to your Hunt representative. His specialized knowledge can save you hours and dollars. Call him today.

For more information, write for Bulletin 603. Address Hunt Valve Company, Salem, Ohio, Dept. AH-761.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

3020

AIR-OPERATED VALVES

Your need for air-operated valves in systems with limited space is answered here. Light weight . . . easy to install, these new AE Air Operated Valves are far more compact than any such units thus far offered. They're designed for on-off use with ⅛, ¼, ⅜ or 9/16 inch stainless steel tubing and for pressures up to 5,000 p. s. i. Your choice of either air-to-open or air-to-close designs.

Complete information is offered in Bulletin 361—yours for the asking.

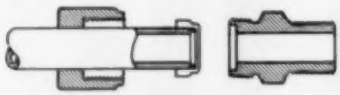
AUTOCLAVE ENGINEERS, INC.

2935 West 22nd Street • Erie, Pa.

Designers and Builders of High Pressure-High Temperature Equipment including: Valves • Fittings • Stirred Autoclaves • Reactors • Pumps • Compressors • Complete High Pressure Package Systems including Instrumentation and Controls.

Circle **13** on Reader Service Card

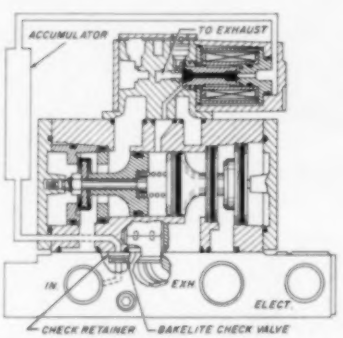
installed on the tube is then tightened onto the fitting, making a sealed joint between tapers of



BRAZED FITTING makes a compact installation and permits easy disconnect.

the sleeve and fitting. This makes a very compact installation and permits close bends.

• **Plug-in Solenoid**—An encapsulated solenoid which plugs in is a feature of Parker-Hannifin's new air valve. The valve also plugs into a base which has an electrical connection box. Viton sealing eliminates problems which might be caused by phosphate ester compressor lubricants. Teflon washers act as bearings as well as back-ups and permit operation with very little lubrication. A seal between the valve and the base incorporates five O-rings in one rubber assembly.



PLUG-IN SOLENOID of this air valve is completely encapsulated. Electrical connections are made in the base.

A check valve traps air in an accumulator to shift the valve in case of line pressure loss. This also makes valve operation independent of line fluctuations, and the valve operates at pressures down to 15 psi. The manual override is not spring loaded. This prevents accidental operation if one man is holding the valve while another is working on the machine.

Continued on page 32

Circle **94** →

A cylinder doesn't think but you do—and when you turn your thoughts to how a machine can perform, a lot of things can happen.

The cylinder responds instantly when activated, and does exactly what you tell it to do with pre-set adjustments. You can synchronize it with the motion of related machines or attach it to a moving machine.

It will produce almost any kind of motion—and do so *without the use of complex mechanical contrivances!*

For more information about Logan products, just fill in the coupon below.

LOGAN

AIR AND HYDRAULIC OPERATED MACHINES

Check the items you want, fill in your name and address, tear out and mail to:

Logansport Machine Co., Inc. • 700 Center Avenue, Logansport, Indiana

___100-1 AIR CYLINDERS
___100-2 MILL-TYPE AIR CYLS.
___100-3 AIR-DRAULIC CYLS.
___100-4 AIR VALVES
___100-5 LOGANSQUARE CYLS.
___100-6 ULTRAMATION CYLS.
___100-7 SUB-PLATE AIR VALVE
___300-1 CHUCKS
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___200-1 HYD. POWER UNITS
___200-2 ROTOCAST HYD. CYLS.
___200-3 750 SERIES HYD. CYLS.
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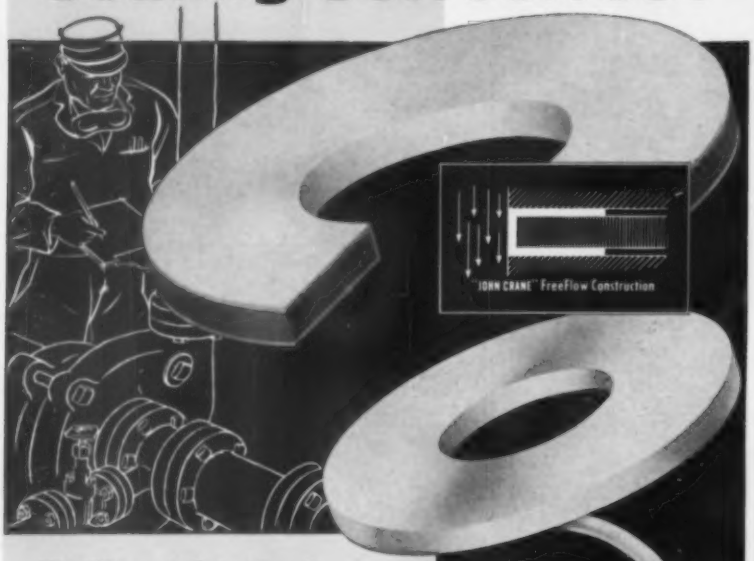
Sealing Corrosives?



Teflon* Gaskets and "O" Rings Definitely Reduce Costs

. . . last for the life of the connection even in services such as concentrated acids, alkalis or solvents (except molten alkali metals).

. . . permit easy joint breaking without tearing or pulling—eliminate replacement cost and lost maintenance time for refinishing flange surfaces.

. . . can be used again and again—assure decided savings where joints must be frequently broken for cleaning and inspection.

Reduce *your* corrosive sealing costs with John Crane Teflon Gaskets, "O" Rings and Back-Up Rings. They are available in a full range of types and sizes, envelope or solid, also specials to specification. Request Catalog P-327 for complete facts.

Crane Packing Co., 6405 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

**DuPont Trademark*

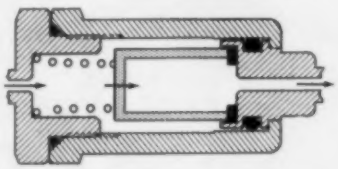
John Crane — MECHANICAL PACKINGS · SHAFT SEALS · TEFLON PRODUCTS · LAPPING MACHINES · THREAD COMPOUNDS

CRANE PACKING COMPANY

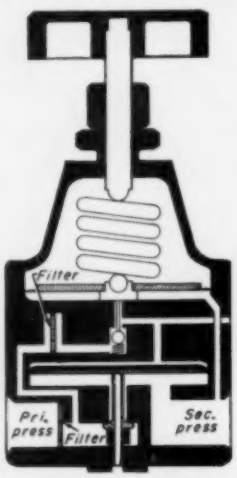
Circle **37** on Reader Service Card

FLUID POWER AT WORK

• **Inline Filter**—The sintered stainless steel element of Nuclear Products' inline filter can be removed without breaking connections. Pressure rating is 3000 psi. Nominal filtration is from 7 to 60 microns.



• **Precision Pressure Regulator**—Accurate control at all flows up to the maximum for ¼-in. pipe; freedom from hunt, hum, and chatter; and exact repeatability and freedom from drift are features of Norgren's new precision pressure regulator. It takes a 0-150 psi inlet pressure and regulates outlet pressure from 0-60 psi. An automatic relief is built in. An extremely small pilot valve motion makes regulation highly accurate. All air is double filtered before it reaches the pilot valve.



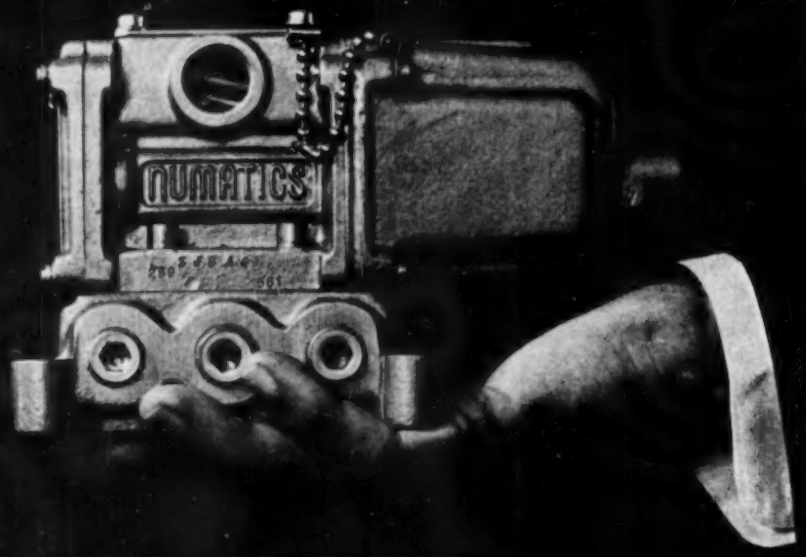
PRECISION PRESSURE REGULATOR has temperature-compensated spring to eliminate spring set. Use of primary air for control results in faster response.

• **Miniature Air Valves**—One-inch diameter and two-inch height are the dimensions of Skinner Electric Valve's new miniature

Continued on page 34

Circle **111** →

this air valve leaks



...15c worth of air

...in one year!

This valve leaks at a rate of about .003 C.F.M. or 15c worth of air in a year. During its unlimited service life the loss will drop to even less. Numatics valves *improve* with service. Unlike poppet valves, there is no blow by from intake to exhaust as the valve shifts.

So what?

You pay 15c a year to get rid-of working resilient seals and the inevitable down-time that results from seal failure in an air valve, because the Numatics valve *has no working seals*. Its stainless steel spool and sleeve, fitted to *millionths* of an inch, needs no working seals!

Run it on any standard lubricant, or run it dry, the Numatics valve is the most reliable air valve on the market!

Buy some!

The lapped spool and sleeve—
it works, and works, and works!

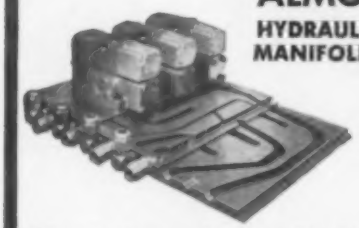
NUMATICS, Inc.

Highland, Michigan

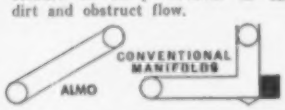
LET'S TALK MANIFOLD FACTS!

The advantages of (Almo) manifolds as opposed to other manifolds are many. Their unique design offers complete flexibility in the mounting of take-offs and valves. Thus an Almo manifold is more adaptable to your requirements. Here are 3 features that definitely effect performance, weight and size.

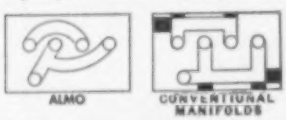
ALMO* HYDRAULIC MANIFOLDS



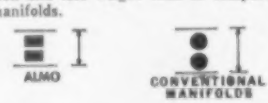
1. Flow lines are short as possible with no corners or sharp recesses to collect dirt and obstruct flow.



2. Method of construction permits better utilization of area, smaller overall dimensions and fewer complications while maintaining correct channel dimensions and constant operating pressures. PSI capacity is a built-in quality.



3. Rectangular cross section of flow lines makes possible thinner overall construction and less weight than in comparable manifolds.



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Let us work with you in improving your product. Write for brochure.

ENGINEERING RECOMMENDATIONS

*"THE UNIQUE FLUID CIRCUIT"

ALMO MANIFOLD & TOOL CO.

11472 KALTZ / CENTERLINE, MICH.

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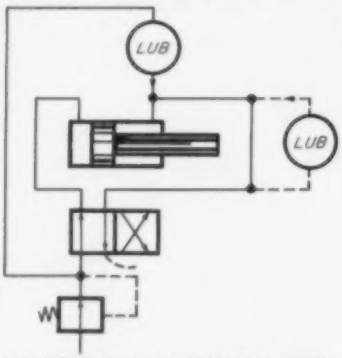
FLUID POWER AT WORK

valves. They have 1/16-in. pipe ports, and 3/64-in. orifices. They weigh 5 oz. compared to 1¼ lb for larger valves of the same orifice size. Spring loading in the valve compensates for rubber shrinkage or swell. A metal-to-metal stop limits rubber compression and protects the seals. Connections can be made with ⅛-in. tubing, and 1/16-in. fittings are supplied with the valve to adapt to this size line.

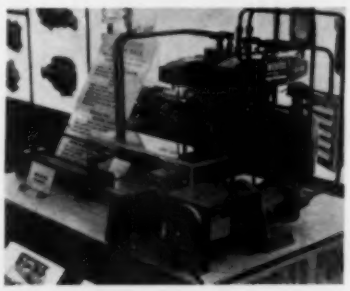
• **Air Lubrication**—A new air line lubricator which works at air flows of only 0.1 scfm is the key to a new lubrication circuit developed by Wilkerson. Connected in the circuit shown, constant pressure is maintained on the lubricator regardless of cylinder operation. On the extend stroke, lubricated air is drawn into the valve along with exhaust air from the cylinder. On the retract stroke, lubricated air is drawn into the cylinder. In the alternate system shown, there is no oil flow through the valve during the extend stroke.



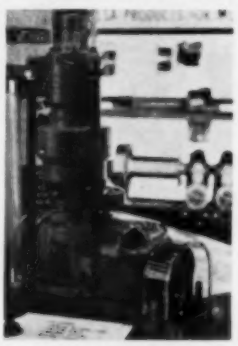
LUBRICATOR FOR LOW AIR FLOW is kept under constant pressure. It supplies lubricated air during both cylinder strokes.

• **Power Pack**—A standard, balanced vane pump with overload relief valve, solenoid control valves, oil tank, and electric motor are combined into a compact, low cost package on Vickers' new power pack. It is also available without a control valve or with a manual valve. Pump capacities range from 1.5 to 8 gpm. Intermittent duty rating is 1500 psi. The electric motor serves as an end bell mounting for the other components, and as a mounting base for the entire package.

Also new at the Vickers' booth was a pneumatic actuator which can be applied to either the pump or motor of a variable speed, hydraulic drive. The actuator can be controlled by variables such as pressure temperature, flow, speed, or chemical characteristics. The transmission can drive chemical metering pumps, transfer pumps, conveyor systems, and other systems. Instrumentation signals of 3-15 psi and 6-30 psi control the actuator. ▼▼▼



POWER PACK incorporates pump, reservoir, electric motor and manifold control valves in low cost package.



PNEUMATIC ACTUATOR which accepts pneumatic instrument signals controls displacement in a hydrostatic transmission.

Repeating Air Hammer

A repeating air hammer, made by Heidrich-Nourse Co., Los Angeles, features internal valving on the order of a two cycle double acting cylinder. The machine is actuated by contact pressure of the tool on the work. When the hammer cylinder with the impact

Continued on page 36

Circle 93 →

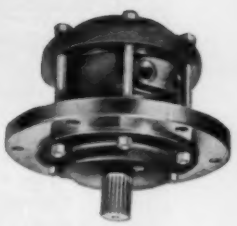
SEMI-ROTARY HYDRAULIC SLAVE UNIT MAKES THINGS...

OVER A WIDE FIELD OF APPLICATIONS

THESE double-acting units give semi-rotary motion up to 300° for single vane and up to 120° for double vane units with torques ranging from 1,270 to 1,100,000 lb/ins. at 1,000 p.s.i. Autoloc mechanical locking can be incorporated and shafts may project at either or both ends. Units can be arranged for foot or flange mounting. Normal maximum operating speed is 2 radians per second.

They have wide application in any field in which oscillatory angular motion is required and are particularly appropriate for the operation of plug valves, vanes, doors, stirring or agitating equipment, sand slingers, etc.

This is just one group of a wide range of Lockheed hydraulic units of which full details will be sent on request. Lockheed engineers are always ready to advise upon the use of units and devise schemes of hydraulic operation and control.



This flange-mounted semi-rotary slave lends itself to many uses, including operating stirrers for liquid and semi-liquid products, and actuating plug or butterfly valves, where the unit can be flange-mounted directly on the valve body: many other such applications are easily arranged.

LOCKHEED PRECISION PRODUCTS LIMITED
INDUSTRIAL HYDRAULICS DIVISION
SHAW ROAD, SPEKE, LIVERPOOL 24, ENGLAND *Hunts Cross 2121* *Telex 62394*
London Office: Automotive House, Great Portland Street, London, W.1 *Langham 2527* *Telex 23446*

Lockheed

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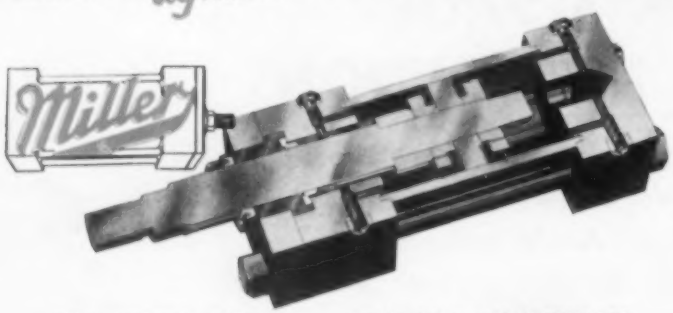
FINEST *dynamic* CUP PACKINGS



Miller Hydraulic Cylinders . . . standardizing with MARSH 312 CUP PACKINGS FOR 15 YEARS . . . for use in nearly 100% PETROLEUM BASE FLUID APPLICATIONS

Mr. Frank Flick, President of Miller Fluid Power Division Flick-Reedy Corporation, has stated, "Applications of over 200,000,000 feet of piston travel with over 200,000,000 reversals have shown *no measurable wear* due to the inherent qualities of the leather."

Miller engineers say, "The self-regulating MARSH 312 Cup Seals result in minimum friction at all pressures . . . provide smooth, chatter-free operation . . . eliminate pumping losses and heat generation . . . permit closely regulated feeds even when heat changes oil viscosity."

Since 1946 Miller has selected Marsh (Resin Impregnated) Leather Cups when working with petroleum base fluids, as their standard.

If you would like information on how impregnated leather packings may answer your sealing problems — with air, gasoline, petroleum base fluids, synthetic fluids or water — WRITE, WIRE, OR PHONE

MARSH BEST SINCE 1900

C·W·MARSH COMPANY

MAIN OFFICE AND FACTORY: 50 HUDSON ST., MUSKEGON, MICHIGAN

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Circle **97** on Reader Service Card

FLUID POWER AT WORK

tool is lowered, it stops on the work material. Further pressure pushes the tool into the cylinder to open the air porting. As long as contact pressure is maintained the hammer will repeat. It shuttles up and down, bouncing against a dead air cushion at the top of the stroke. The movement of the hammer opens and closes the porting at each end of the travel. Impact frequency varies from 3,000 to 8,000 times per minute, depending on the applied air pressure. A depth stop may be set to limit work progress. When the depth is reached, the hammer action stops.

A related series of single acting or one-shot impact presses are also produced. In these, the valve is external and is actuated after the tool is brought to rest on the work material. ▼▼▼

FPS News

The Fluid Power Society has been formed to further the development and use of fluid power. Membership information is available from headquarters at 5595 N. Hollywood Ave., Milwaukee 17, Wisc.

• **Cleveland**—Ever operate a 40-foot, utility aerial tower? That was the fun and excitement to which Cleveland section members were treated at their May meeting. About 90 people attended the meeting.

George Eckels, vice president in charge of engineering, Holan Corp., Cleveland, parked a truck-mounted, aerial tower outside the Cleveland Engineering Center and let one and all become experts at handling the utility tower. The demonstration was effective. Later, Mr. Eckels described in detail the hydraulic development of the tower.

Fluid power is used extensively on the machine. A hydraulic

power swivel lets the tower rotate 360 degrees continuously. Two

Eckels

cylinders raise the mast to its extended height of 40 feet. The tower can be controlled either from the ground or by remote control from the tower's fiberglass working bucket. System pressure is 2000 psi.

Ballots for electing officers for the coming year will be mailed during June. New officers will assume their duties in September.

• **Minneapolis-St. Paul**—The major order of business at a recent meeting of this section was the election of officers for the coming year. The following men were

Continued on page 40

BRIEF NOTES

ADDITIVES EXTEND RANGE OF SEAL RING APPLICATIONS . . . The effect of additives on carbon graphite seal rings was recently explained at a meeting of the American Society of Lubrication Engineers. Dr. D. Ramadanoff and J. J. Sherlock, National Carbon Co., Div. of Union Carbide told how the proper use of organic and inorganic additives can add many new uses to such seals.

ORGANIZE COMMITTEE ON REMOTE CONTROLLED VEHICLES . . . Increasing need for technical information and data on remote controlled vehicles has lead to the formation of subcommittee XIX, Society of Automotive Engineers. Its task will be to collect information about remote controlled vehicles.

SEALS FOR 5000 PSI, 1200 F. . . . Armour Research Foundation, Chicago has developed seals that have withstood pressures to 5000 psi at temperatures to 1200 F. These experimental static seals were made by impregnating strong metal fiber skeletons with soft filler metals.

"SLIPPERY" RUBBER DEVELOPED . . . Quantum, Inc., a research laboratory, Wallingford, Conn., has developed rubber that is slippery, yet retains the elasticity and other desirable properties of natural or synthetic rubber. Significance of this development is the possibility of designing seals for rotary and reciprocating shafts that would last longer without lubrication.

ASA BOARD ELECTS SIMON . . . Carl H. Simon, executive vice president and general manager of Darling Valve & Mfg. Co., has been elected to the Board of Directors of the American Standards Association for a three-year term. He will represent the valve and fittings industry.

BUSINESS BRIEFS

DIAPHRAGM INDUSTRIES OPENS NEW PLANT . . . Diaphragm Industries, Inc., Beverly, Mass., announces the completion of new design and manufacturing facilities. The company manufactures diaphragm and diaphragm assemblies for aircraft and industrial applications.

R. P. ADAMS CO. OFFERS NEW PRODUCTS . . . Shell and tube type heat exchangers will be offered by R. P. Adams, Buffalo, N. Y., in addition to the U-bend and straight type tube designs the company now makes.

PARKER-HANNIFIN EARNINGS CLIMB . . . Third quarter earnings for the current fiscal year were $743.032 or 56 cents per share compared to $553,960 or 43 cents per share for the same quarter a year ago.

COOPER-BESSEMER BUYS PUMP, MOTOR MANUFACTURER . . . The Kline Manufacturing Company, Galena, Ohio was purchased by the Cooper-Bessemer Corp., Mount Vernon, Ohio. The Kline Co., manufacturer of hydraulic pumps and motors, will operate as a wholly-owned subsidiary of Cooper-Bessemer.

USE THE COUPON BELOW FOR MORE INFORMATION ON NEW ECONOMICAL

PYROGARD C
FIRE-RESISTANT FLUID

See ad on following pages

Mobil

Mobil Oil Company, Room 2058C
A Division of Socony Mobil Oil Co., Inc.
150 East 42nd Street, New York 17, N.Y.

Gentlemen: I am interested in learning how new PYROGARD C fire-resistant fluid can aid my operation.

NAME _____
POSITION _____
COMPANY _____
ADDRESS _____
CITY _____
ZONE STATE _____

Circle **105** on Reader Service Card

FOR IMPROVED PLANT SAFETY PLUS

NEW, ECONOMICAL

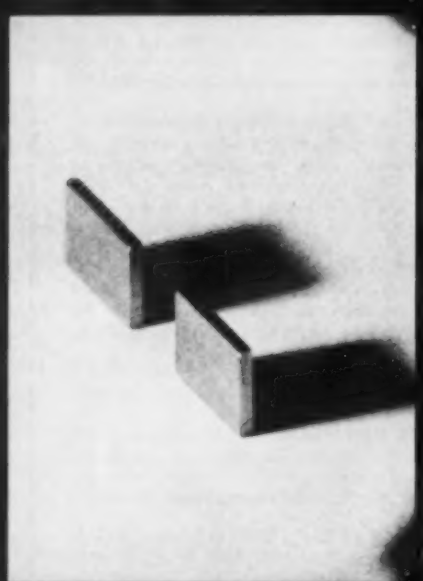
PYROGARD C

FIRE-RESISTANT FLUID

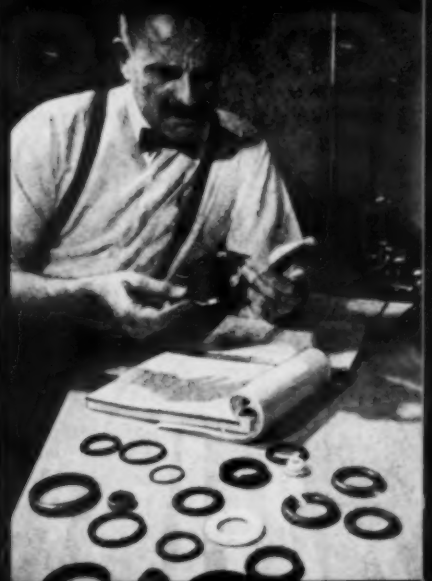
Mobil

HERE'S HOW PYROGARD C CAN HELP YOU!

Ignition resistance increases plant safety—PYROGARD C helps you protect your property and personnel against fire. Ignition resistance is demonstrated here. Hydraulic oil (left) bursts into flame immediately while PYROGARD C (right) resists combustion when poured onto steel plate heated to 1000F.



Good anti-wear properties assure long pump life—PYROGARD C fire-resistant fluid is designed for most pumps and pressures encountered in plant hydraulic equipment . . . gives excellent protection against pump wear for fluids of this type. Pump vane at left is new. Vane at right has 1000 hours of service with PYROGARD C at 160F and 1000 PSI. Wear is almost undetectable.



Compatibility with seals, metals eases fluid installation—PYROGARD C fire-resistant fluid is easily installed because it has no adverse effect on most packings, seals, or hoses, and is non-corrosive to metals normally found in plant hydraulic systems. Containing effective rust inhibitors, PYROGARD C fire-resistant fluid gives excellent protection against rusting wherever it contacts metal.

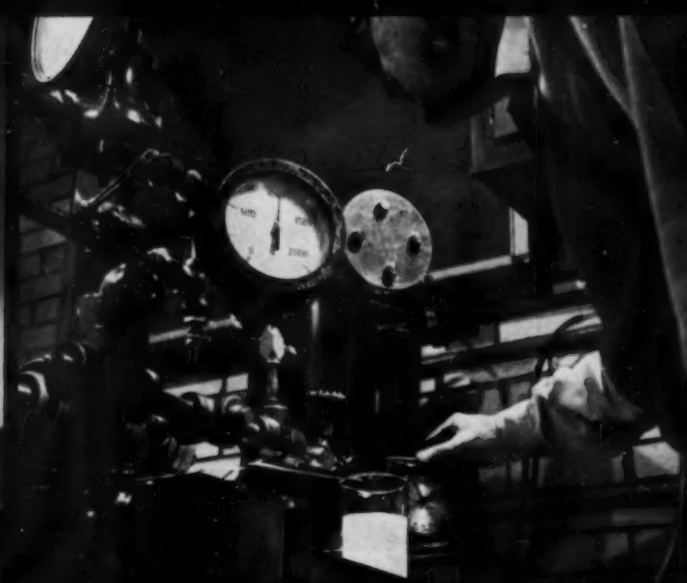
POSITIVE HYDRAULIC RESPONSE...

Now, the makers of world-famous Mobil petroleum hydraulic oils bring you PYROGARD C, a new fire-resistant fluid that offers positive hydraulic response plus improved plant safety . . . at low cost.

PYROGARD C fire-resistant fluid is a water-in-oil emulsion containing special chemical addition agents. It's been thoroughly field tested in actual service . . . will give excellent performance under conditions such as those encountered in press welders, furnace-door openers, ladle-tilting mechanisms, scrap balers, and die-casting machines.

The major benefits provided by PYROGARD C fire-resistant fluid are detailed below. In addition you receive the help of experienced Mobil Engineers in applying it to your equipment. Their specialized know-how in the installation and maintenance of fire-resistant fluids will make the procedure sure and simple. Examine the benefits of PYROGARD C fire-resistant fluid —then contact your nearest Mobil Representative.

Long-term stability in storage and use assures uninterrupted production—PYROGARD C fire-resistant fluid is highly stable even at higher-than-normal temperatures—resists breakdown, foaming and water separation—keeps pump parts and screens free of deposits. And with PYROGARD C, water evaporation is retarded by a thin oil skin that forms when the emulsion is at rest, yet readily remixes when fluid is agitated (shown above).



Unusual flow properties assure positive hydraulic response, yet reduce leakage—PYROGARD C fire-resistant fluid has unusual viscosity characteristics . . . resists leakage at static joints, yet gives rapid flow and response elsewhere in the system. In apparatus above, a specially designed "leak chamber," introduced into hydraulic system, shows the PYROGARD C leaks less than ordinary hydraulic oil.

MOBIL OIL COMPANY, 150 East 42nd Street, New York 17, N. Y.

chosen to guide the chapter. President: John L. Rodgers, Jr., Rodgers Hydraulics; vice-president: James Miller, Motec Industries; secretary: Wallace Jenkinson, Hydra Power Engineering; treasurer: Henry Geer, Erickson Power Lift Trucks, Inc.; delegates: Carl Brown, Motec Ind., and Geo. Carlson, Minnesota Rubber.

After Barrett Rodgers, FPS National secretary, presented the chapter its charter, the members saw a film on hydraulic fluids, and discussed NFPA cylinder identification coding. ▼▼▼

MSOE holds seminar on fluids

MILWAUKEE—A one-day seminar on hydraulic fluids was held at the Milwaukee School of Engineering on May 23. The seminar was sponsored by MSOE in cooperation with the Milwaukee Chapter of the Fluid Power Society, and was attended by about 40 men from industry.

• **Oils for Mobile Equipment**—Mr. Edward Yatsko, Jr., senior project engineer, Products Application Department, Shell Oil Co., Chicago, discussed hydraulic oils for mobile equipment. He pointed out that for satisfactory performance in any hydraulic system, a fluid should meet the following requirements:

- Be a good lubricant
- Maintain minimum change in rate of flow between highest and lowest working temperatures
- Resist emulsification and foaming
- Resist chemical breakdown
- Protect against rust and corrosion
- Be stable and resistant to change of initial breakdown

The widespread use of petroleum oils in mobile equipment is ample proof of their ability to fulfill these requirements. It must be noted that while fire-resistant fluids such as phophate esters and water-glycol solutions do offer much needed protection in many hazardous industrial applications, such fire hazards seldom exist in outdoor mobile equipment.

Petroleum base fluids occupy a dominant position in the mobile equipment field because they combine satisfactory performance with general availability and reasonable cost.

• **Fire-Resistant Fluids**—The four basic types of fire-resistant fluids commercially available were described by John A. Mathe, lubrication engineer, E. F. Houghton & Co., Philadelphia. They are, water-glycol, phosphate ester, mixture of phosphate ester and chlorinated hydrocarbons, and water-in-oil emulsions.

Water-glycol solutions have good fire resistant properties, and can be used with standard butyl rubber seals. They should not be used at temperatures over 135 F, however, and do not provide suitable lubrication for use with antifriction bearings.

Continued on page 45

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Compare overall stack heights shown in the table below, and you'll see what we mean. Listed are so-called "standard" heights of ¼" 3-ring fabricated "V" packings offered by six major manufacturers. Overall heights range from a low of ⅝" up to 1 9/64" high . . . *a variation of more than* ½".

COMPARATIVE STACK HEIGHT OF FABRICATED "V" PACKINGS PLUS ADAPTER NOW OFFERED

C/S	SOURCE	3/SET
¼"	Mfgr. A	25/32
	" B	41/64
	" C	1 9/64
	" D	45/64
	" E	5/8
	" F	23/32

This means that in laying out a gland for fabricated "V" packings, the designer must first determine which manufacturer he wants to buy from before he completes his design. And once the gland is made for this particular brand of packing, replacements of the same brand are almost mandatory. Another handicap—switching to a leather or homogeneous packing later would be extremely difficult because of the difference in stack heights.

The use of Standard J.I.C. stack heights for fabricated "V" packings is the obvious answer to this problem. Yet, today Houghton is the only packing manufacturer who offers you uniform stack heights for *all three* major "V" packing materials—fabricated, homogeneous and leather—making them interchangeable with respect to dash number, O.D., I.D. and stack height.

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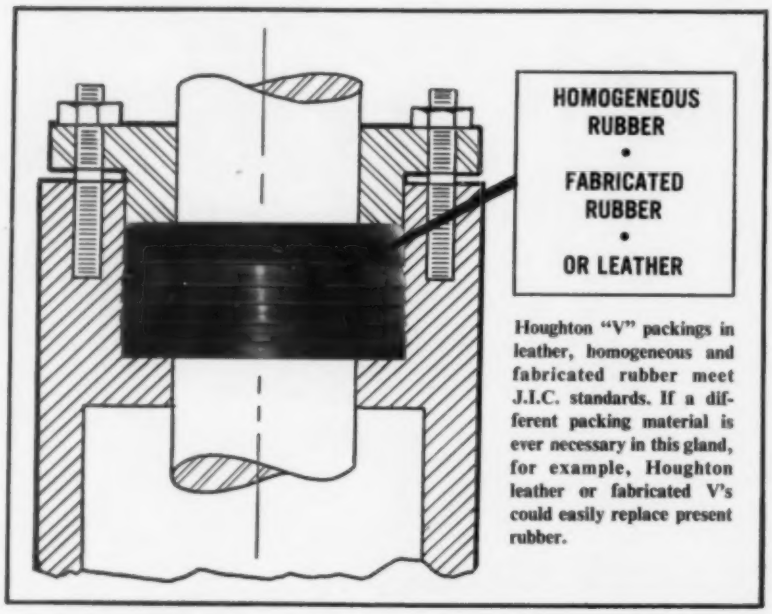
You can use a leather V for anti-extrusion, strength, and low friction with rubber rings for wiping efficiency and low cost. You can switch from homogeneous rubber to fabricated to gain extra strength. You can even use V's of all three materials in the same gland.

Leadership in packing standardization is another reason major hydraulic and pneumatic equipment manufacturers consider Houghton "packing headquarters". Houghton is also the only manufacturer who offers a *complete* line of packings and fluids for almost any industrial hydraulic system. This experience in both fields is your guarantee of a completely unbiased recommendation of compatible materials . . . the very best for your particular application. For more information or help, call or write: E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.



Houghton "V" packings in leather, homogeneous and fabricated rubber meet J.I.C. standards. If a different packing material is ever necessary in this gland, for example, Houghton leather or fabricated V's could easily replace present rubber.

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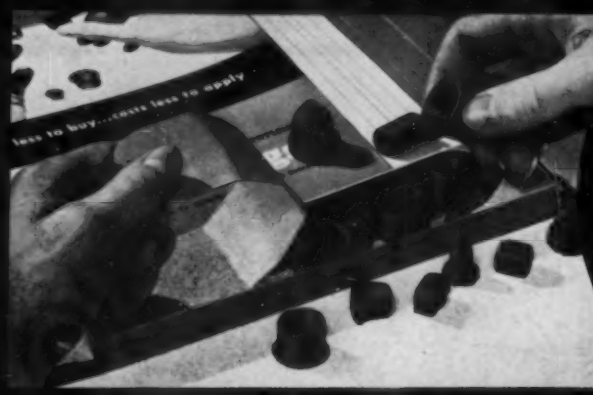

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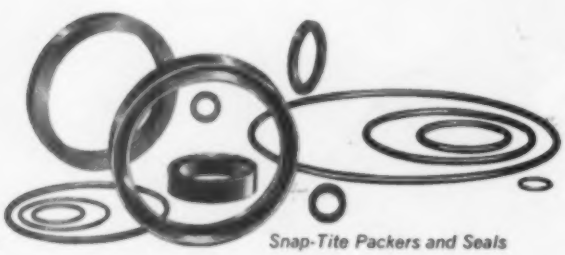
A complete choice of packers and seals permits Snap-Tite quick-disconnect couplings to handle over 600 different fluids! *(some of them mighty tough)*

Whatever fluid you're working with, chances are Snap-Tite couplings can handle it. Because every-one of the thousands of Snap-Tite quick-connect valved couplings comes with a wide choice of rubber packers and seals, selected according to the fluid in use. The right choice, of course, is vital for the seal is the very heart of the coupling.

To assist you in the proper selection of coupling seal material, Snap-Tite, with the assistance of suppliers of synthetic rubber materials, has recently compiled a comprehensive Packer Usage Guide —the first of its kind in the industry.

For the Packer Usage Guide, and for complete information on the correct choice of quick-connect, quick-disconnect couplings for the fluids *you* use, write Snap-Tite, Inc., Union City, Pa.



Snap-Tite Packers and Seals

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UNION CITY, PA.

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Phosphate ester fluids can be used at high temperatures. They provide the best lubricity characteristics of any of the fire-resistant fluids. They will also lubricate any design pump, but must have compatible seals.

Mixtures of phosphate esters and chlorinated hydrocarbons are difficult to seal, and have severe chemical effects on seals.

Water-oil emulsions are usually made 40% water, 55% petroleum oil, and 5% emulsifier. Each drop of water is coated with a film of oil. At high operating pressures, however, the fluid does not have the lubricity of other fire-resistant fluids. This is probably due to lack of stability, an inherent problem with this type fluid.

• **Fluids for Hot Hydraulics**—Richard L. Leslie, supervisor, Fluids & Chemistry group, Vickers Inc., discussed problems of fluids used for high temperature hydraulics. Essentially, the development of fluids for high temperature hydraulics is still in the research stage. A fluid must have the same properties when operating at high temperatures as at lower temperature. It must, however, be much more stable, it must have good lubricating properties, have reasonable viscosity, compressibility, and gas absorption.

SPEAKERS at the seminar on hydraulic fluids were (l. to r.) Edward Yatsko, Jr., Shell Oil Co.; John A. Mathe, E. F. Houghton & Co.; Ward F. Diehl, General Motors; and Richard L. Leslie, Vickers Inc.

To cope with high temperatures, liquid metals such as liquid sodium, and liquid sodium potassium have been considered. Even mercury has been proposed, but its high specific gravity (13.6) is its greatest drawback.

The advancing space age will need hydraulic fluids that will also withstand nuclear radiation. Controlling nuclear reactors hydraulically seems feasible but to make hydraulics practical, radiation-resistant fluids will have to be developed.

• **A User Speaks on Hydraulic Fluids**—Mr. Ward F. Diehl, supervisor, Fluid Power Control Group, Manufacturing Development Section, General Motors Corp., made these comments about hydraulic fluids.

- The life expectancy, quality control, and dependability of hydraulic fluids have been greatly improved in the past 20 years.
- Hydraulic equipment design and application is the biggest factor in selecting a hydraulic oil. Leakage, fire hazards, operating temperature, environment, and cleanliness are the determining factors that will dictate the type of fluid to be used.
- The most economical operating conditions are obtained when using well designed, properly adjusted equipment together with the best available oils at optimum temperatures. In actual plant operation, there are many factors which make such ideal situations impossible. There is a lack of standards in the industry regarding machinery design and construction. Many plants often have machines of various designs and age. This makes maintenance practices difficult to standardize. In many plants there is a lack of oil purchase specifications. Turnover of personnel, and a lack of understanding on how hydraulic equipment should be maintained is often responsible for much unnecessary downtime and maintenance. ▼▼▼

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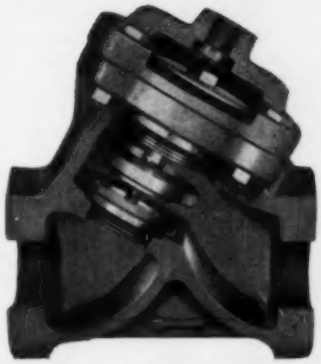

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NFPA GAINS 15 NEW MEMBERS

WHITE SULPHUR SPRINGS, W. VIRGINIA—A record attendance was set at the ninth spring meeting of the National Fluid Power Association. Meeting here during the third week of May, the association welcomed 15 new member companies. There are now 72 manufacturers of products for fluid power systems in the NFPA.

Companies who have joined since last July are:

> AE Industrial Division, Aircraft Armaments, Inc.; Crane Packing Co.; Disogrin Industries; Fluid Power Accessories Co.; Greene, Tweed & Co.; Hydraulic Power Div., HPM; Hydraulic Accessories Co.; Hydraulic Products Div., Clark Equipment Co.; Mo-Bar Hydraulic Sales Co.; Moog Servocontrols, Inc.; Owatonna Tool Co.; Snap-Tite, Inc.; Superior Hydraulics Div.; Tubular Products Div., Babcock & Wilcox Co.; and Wilkerson Corp.

● **FLUID POWER SOCIETY**—One of the projects undertaken by NFPA is the sponsorship of a technical society for users of hydraulics and pneumatics. Barrett Rogers, NFPA's executive vice-president reported:

> The Fluid Power Society is now completing its first year. Sixteen chapters have received charters in the United States; two in Canada. Membership is over 1000. Some chapters have maintained regular technical programs this year. (See HYDRAULICS & PNEUMATICS, April, page 40, June, page 30). Among the society's goals are the establishment of an international committee on fluid power education and a program of standardization.

● **NFPA PUBLICATIONS**—Three publications are available. The second edition of the *Glossary for Fluid Power* defines over 300 terms. A *Recommended Dimension Identification Code for Fluid Power Cylinders* is published in a 24-page booklet. The third publication called, *Story of Men Working Together* tells what NFPA is and the role of fluid power in design and production.

One publication service of NFPA available presently to members only, is a Patent Research Service.

New publications being prepared include an index to available standards and a bibliography of articles about fluids.

● **ENERGY FOR INDUSTRY**—That's the slogan adopted by NFPA. Announcing the selection of the slogan, public relations board chairman George Carlson, Minnesota Rubber Company, also showed the use of the slogan with the NFPA emblem.

Carlson also announced the establishment of a Distinguished Service Award to give recognition to an individual for his accomplishments in the fluid power field. It is planned to make the first award in 1962.

● **MARKETING**—David Fromson, NFPA's Counsel presented a paper "Pricing Problems Under the Anti-Trust Laws".

John Petersen, Racine Hydraulics, reported on the Fluid Power Sales Index which is now developing as the result of sales statistics being supplied by member companies. He showed how this, along with other leading indicators can be used for sales forecasting. Other indicators include: capital appropriations for metalworking which are ahead of expenditures by 9 to 12 months; money supply; screw machine product sales; machinery orders; and a gear index developed by the American Gear Manufacturers Association.

The Fluid Power Sales Index will be stabilized on a calendar year basis. Monthly reports giving a composite index are sent to participating companies.

● **GOVERNMENT ACTIVITY**—Charles F. Hughitt, Director of General Industrial Equipment & Components Div., BDSA, U. S. Department of Commerce spoke at the meeting. His division released the report of 1957 market data for fluid power. This reported sales of pumps, valves, cylinders, motors, compressors and accumulators. The figures are very different from those reported by the Census Bureau for 1958. These differences emphasize the difficulties in proper definition of components for fluid power application. No continuing report for fluid power is presently planned by BDSA.

● **TECHNICAL ACTIVITIES**—R. L. Curtis, Tomkins-Johnson Company, who heads the Linear Devices committee reported the increasing use of the identification code for cylinders. Copies of the code are being used by field men of many cylinder manufacturers. And as new cylinder catalogs are prepared it is expected that the code will result in greater uniformity to make it easier for users of cylinders to make design drawings.

A sheet showing a proposed code for cylinders was shown. The goal of this project is to provide a code number for each cylinder which would show:

> Type of cylinder (air, oil, etc.), mounting style, bore, cushioning, rod end type, rod size, stroke, operating medium (air, oil, F-R fluid, etc.), piston packing.

This project is in preliminary stages.

Seven meetings have been held by the Accumulator Committee headed by H. H. Schmiel of Parker-Hannifin. Their goal is to prepare and accumulator safety code recognized by ASA, insurance underwriters and state industrial boards.

Classification coding of fluid power products is another project of NFPA. Jim Fisher of Bellows-Valvair says their work is based on information compiled in HYDRAULICS & PNEUMATICS magazine's Designers Guide Issue published every January. The numerical classification system will help manufacturers using data processing equipment for production control, order picking, and market analysis.

The Pneumatic Valve Committee has three major projects:

1. Compatible coding system for valves used for both air and oil.
2. Valve ratings such as flow and response time.
3. Standardized test procedures.

Walter Kudlaty, Flick-Reedy Corp., who heads the Terminology Committee showed a completed chart of information on sealing materials. This useful chart defines terms and includes 77 tradenames.

● **NEW OFFICERS**—At the closing session, Frank Flick, NFPA's 1960-61 president, introduced officers for the coming year: W. C. Richards, Jr., Bellows-Valvair, president; Oliver G. Lear, Sarasota Products, 1st vice president; Otto Maha, Hannifin Div., 2nd vice president; W. B. Kuhnke, Hanna Engineering, treasurer. New directors are: Ed Karns, Cessna Aircraft; Harvey Sheffer, The Sheffer Co.; and Jack Rowe, Tomkins-Johnson.

Next meeting will be in Philadelphia, October 24-26. ▼▼▼

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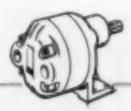
MOTORS

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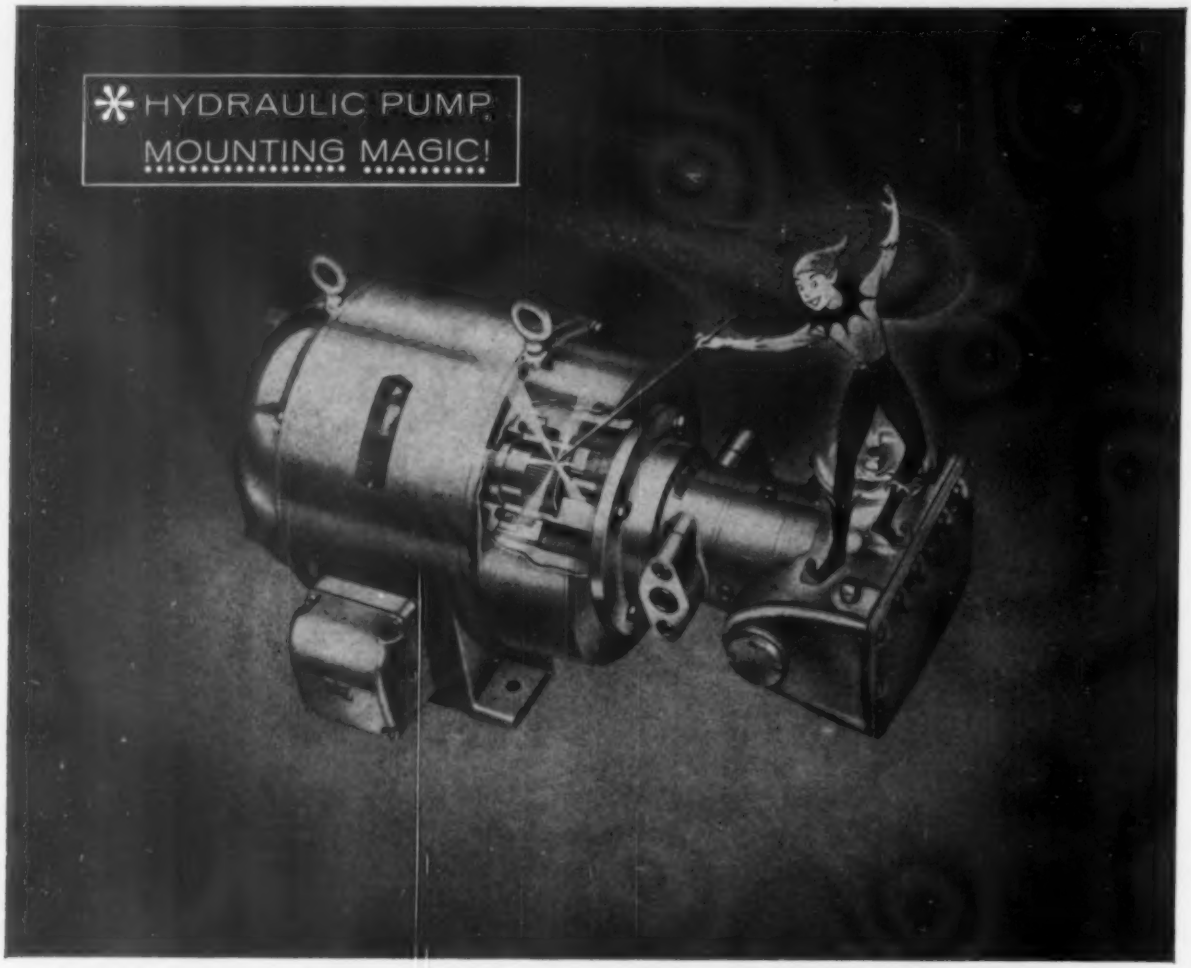

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Pump and motor become *one* with the new Reuland spline-coupled hydraulic pump hook-up. The pump shaft is connected directly to the motor's shaft *inside the motor*. Flexible couplings are eliminated... pump mount platforms are eliminated... and the tank length can be reduced because almost 50% less mounting area is required. Compact appearance is beautiful.

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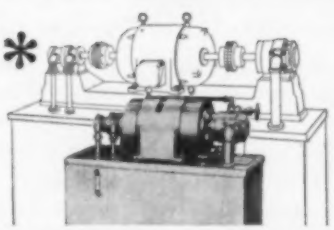
Pump-to-motor hook-up is merely a matter of seconds. All you do is slip the spline coupling onto the pump shaft...and attach the pump to the endbell. This spline coupling is supplied with the motor and is precision mated for each make of pump. There's no time wasted tinkering around... takes only a fraction of the ordinary time.



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Alignment is perfect *automatically* whether the installation is made out in the field or on the production line. This permits even unskilled workmen to handle this simple task without error. Also, by hooking the pump up at the point of bearing support, within the motor, vibration is reduced to a new minimum. Operation is smooth, quiet.

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Refer to Sweet's 1961 Product Design File, Section 7a/RE

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FLUID POWER AT WORK

NCIH plans papers, speakers

Keynote speaker for the National Conference on Industrial Hydraulics will be Dr. Leslie W. Ball, Boeing Aircraft. Dr. Ball will emphasize reliability from the standpoint of organization administrators. The conference is scheduled for October 20 and 21, Hotel Sherman, Chicago. Papers are now being prepared by more than 20 authors. Papers on these subjects have been accepted by the program committees:

- Components and Accessories—Reservoir design and new proportional valve developments.
- Machine Tools—Reliability in fluid power applications from the points of view of the manufacturer and the user.
- Pneumatics—Full automation for conveyors; controls and gauging on in-feed grinders; and use of pneumatics in newspaper stackers.
- Pumps—Dredges and equipment for marine applications; and new design theory for high pressure pumps.
- Materials Forming Machinery—High pressure (100,000 psi) systems.
- Mobile equipment—Circuit developments. Hydrostatic transmissions.
- Servo-Mechanisms & Systems—Designs for printing presses and radar antenna drives.
- Missiles & Space Hydraulics—Problems of missile hydraulic thrust vector control system; fluid power for missiles; high temperature seals.
- Aircraft Systems—Hydraulic control system (20 to 1000 F); realistic approach to reliability in hydraulic system for carrier operation; and application in commercial transports.
- Automotive—Vehicle ride stabilization by inertia control; hydraulic power steering.

Attendance at this 17th annual conference is open to anyone interested in fluid power. Conference Director is Frank Mackin. Sponsors are Illinois Institute of Technology, professional engineering societies, and manufacturers of fluid power components.

Further information is available from Wm. Smith, NCIH, Illinois Institute of Technology, 3300 S. Federal St., Chicago 16, Ill.

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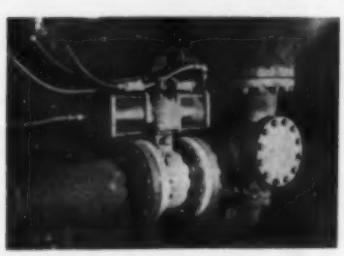

BALL VALVES, manufactured by Jamesbury Corp., Worcester, Mass., are finding extensive use for controlling digester discharge in paper mills. The St. Joe Paper Co., a mill with ten, 4300-cu ft digesters, uses the valves to discharge kraft pulp from each digester in eight minutes. The valves are air-operated and controlled from the operation floor.

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Hydraulic Cylinders

- Basic Designs
- Specific Adaptations
- Superior Quality
- Application Engineering

BHEW'S 3000 PSI SERIES GENERAL-PURPOSE CYLINDERS, designed around component parts but custom-built to *your* specifications, are available in a variety of mountings, in sizes 1½" through 6", with adjustable or non-adjustable rod ends or without rod ends. These are rugged cylinders for OEM.

- Self-adjusting "V" packed rod glands • "U" cup seal on pistons • Honed steel barrel, high tensile hard chrome-plated rods • Packings available for high and low temperature extremes, most non-inflammable fluids.

Production parts save you money, do the job better! BHEW basic cylinders can easily be modified to fit your *specific* product applications. You benefit from production economies; you get custom-built cylinders.

Let's discuss your design and application problems —

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Write today for Hydraulic Cylinder Engineering Reference data — 78 dimensional basic designs for general-purpose and special-purpose double-acting and single-acting cylinders. SAVE TIME.

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Practical solutions to many of today's high-pressure (10,000 psi) hydraulic problems begin right here

. . . in the Greenlee Hydraulics Test Laboratory

Do you have a problem involving hydraulic pressures in the 10,000 psi area? Quite likely GREENLEE can be of help — either with our standard line of pumps and valves, or with adaptations engineered for your specific applications.

For many years GREENLEE has manufactured hydraulic equipment operating at high pressures. And as *specialists* in this field, our pump and valve engineers have worked closely with many other manufacturers on the development of a wide variety of mechanisms using 10,000 psi for plant, laboratory, or field use.

The hydraulics section of GREENLEE includes complete engineering, testing, and manufacturing facilities. Why not put them to work on your 10,000 psi problems? Write us today, outlining your requirements.

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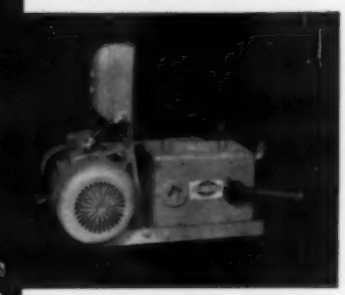
HIGH-PRESSURE, TWO-SPEED portable power pumps by Greenlee feature high volume, low pressure for fast-approach ram action and automatic change-over to low-volume, high-pressure drive. Lightweight series: 10,000 psi intermittent, 6,000 psi continuous. Heavy-duty series: 10,000 psi continuous. Portable—self-contained units. Choice of two-way or four-way valves.



HIGHER VOLUME, HIGH-PRESSURE Greenlee No. 797 power pump features extra-high-speed drive at high pressure. Up to 213 cu in. per minute at 10,000 psi. Pump, reservoir and control in one compact unit. Electric-motor or gasoline-engine driven. Choice of two-way or four-way valves. Mobile undercarriage optional.

GREENLEE HYDRAULIC VALVES for hydraulic systems up to 10,000 psi pressures. Two-way, three-way, four-way, flow control and free-flow metering types. (Four-way, spool type illustrated above.) Designed for integral or remote control of Greenlee pumps and for use on a wide variety of other hydraulic applications.

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here's a pilot you can trust!

In hundreds of thousands of heavy-duty industrial air valve applications, Valvair pilots have proved their ability to provide trouble-free performance and multi-million cycle dependability. They offer maximum simplicity, with but two moving parts . . . flow-through cooling, with air passing through the center of the pilot for heat dissipation during rapid cycling . . . low current draw to prevent overheating, even when continuously energized for hours, days or weeks! And, Valvair pilot coils are potted in resin for moisture-resistance . . . are guaranteed against burn-out for the life of the valve.

What's more, Valvair's pilot is truly universal . . . interchangeable for use on any Speed King® valve. There's no need to stock a confusing quantity of different pilot assemblies or a myriad of parts. So, stockroom and in-service maintenance problems are minimized.

Pilot performance is vital to the dependable operation of the machinery you design, build or use. Your nearby Bellows-Valvair Field Engineer can show you why Valvair's pilot is the one you can trust.

Bellows-Valvair

For more information, write for Bulletin FL-61. Address Bellows-Valvair, Akron 9, Ohio, Dept. AH-761.

AKRON 9, OHIO

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

8192

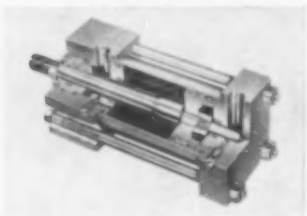
NEW PRODUCTS

Circle the numbers on the Reader Service post card for more information

CUSHION-TYPE AIR CYLINDERS

Positive sealing cushions with adjusting screws allow free flow of air for rapid acceleration. Easily serviced rod cartridge, removable with a wrench. Rod cartridge O-rings seal and maintain tension preventing longitudinal motion.

Specifications: Dimensionally interchangeable. Air pressure, 250 psi. Bore sizes 1½" to 14". 20 standard mountings. Meet all J.I.C.



standards. Teflon rod wipers. Buna-N modified U-cup packings, self-adjusting. Heads and mountings machined from solid steel bar stock. Seamless brass cylinder tubes with mirror-finished I.D.

Designation: A Series.—*Sheffer Corp., Cincinnati, Ohio.*

Circle **300** on Reader Service Card

AIR-OPERATED VALVES

Used in systems requiring remote on-off operation. And relief valve systems where positive re-seating, and safe operation in case of air or electrical failure is provided. Available in air-to-open and air-to-

close designs. Compact for space limitations.

Specifications: Air operator for on-off use with 1/8", 1/4", 3/8", and 9/16" tubing. Pressures to 5000 psi.—*Autoclave Engrs., Inc., Erie.*

Circle **301** on Reader Service Card

DIRECT-ACTION GAUGES

Spring-loaded, pressure sensing mechanism is protected from shock damage and pressure overloads by built-in dampening device. Indicating mechanism has a positive stop to insure accuracy. Replaceable internal parts are interchangeable. No special tools or skilled labor required for maintenance.

Specifications: Size, 2¾" wide x 2¾" high x 1⅝" deep. Completely enclosed in hammer-tone finished aluminum cases with clear plastic faceplates. White, corrosion-resistant plastic dial faces. Easy-to-read, black calibration numerals and graduation lines. Screw in front of gauge permits zero adjustment. In

0 to 500, 0 to 1500, 0 to 3000, and 0 to 5000 psig ranges.—*A. Schrader's Son, Div. Scovill Mfg. Co., Inc., Brooklyn.*

Circle **302** on Reader Service Card

LOW PRESSURE SWITCH

Capsular-type sensing element reduces any pressure set point changes by thermal reaction. No connecting linkages, no tolerances to change.

Specifications: Pressure 7 psig. Deadband only 2" water. Repeatable accuracy ±.5%. Temperatures from −65 F to 300 F. Weighs 2

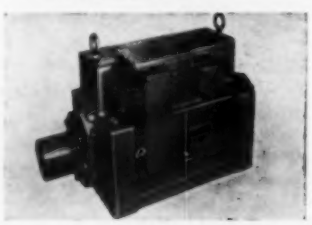
oz, takes 3 cu-in. space. Standard ¼ NPT pressure ports.—*Pamar Electronics Co., Inc., Subsidiary of Hoke Inc., Cresskill, N. J.*

Circle **303** on Reader Service Card

TWO-STAGE SERVO VALVES

Two valves are applied to screw-down power cylinders in two-high, non-reversing cold mill. Mill processes steel plate from .005" to .120". Two other valves control reset cylinders on same application.

Specifications: Low power signals control valves for both uses. Power cylinder valves have pressures to 3000 psi at 250 gpm. Size 24" x 12" x 14". Weight 500 lbs. Reset cylinder valves have pressures to 3000 psi at 25 gpm. Size 15" x 9" x 10". Weight 100 lbs.



Designation: Servocontrol.—*Oilgear Co., Milwaukee.*

Circle **304** on Reader Service Card

Continued on page 54

Aeroquip Introduces New Low-Cost Reusable Fitting for High Pressure Hose Lines

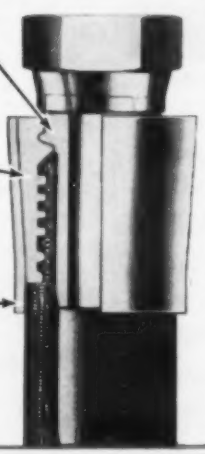
How IRON MIKE Fitting Grips Hose

NIPPLE
Designed to fit into hose without cutting inner tube. Available in 10 end fitting styles.

SEGMENTS
Grip hose reinforcement securely, mate with nipple assembly for correct positioning.

SOCKET
Forced over segments during assembly to form a rugged compression fitting that won't blow off.

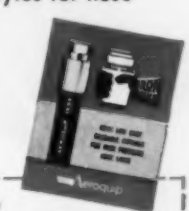
PATENT APPLIED FOR



Meet IRON MIKE, a rugged new hose fitting that provides all the field service advantages and replacement economy of reusable fittings—at rock-bottom prices. Hose assemblies made with IRON MIKE Reusable Fittings compare in cost with assemblies made with non-reusable fittings. Design is so simple that foolproof assemblies can be made by factory or service personnel in minutes.

IRON MIKE Fittings have been field tested for more than a year to assure traditional Aeroquip performance and dependability. Used with Aeroquip 1509 Multiple Wire Braid Hose, they are recommended for all industrial high pressure hydraulic applications up to 2250 psi. as well as pneumatic, fuel and lubrication systems. IRON MIKE Fittings are available in ten standard end styles for hose sizes from ¾″ to 2″ I.D.

Mail coupon below for new Aeroquip Bulletin No. 651.



Aeroquip

AEROQUIP CORPORATION, JACKSON, MICHIGAN

INDUSTRIAL DIVISION, VAN WERT, OHIO • WESTERN DIVISION, BURBANK, CALIFORNIA • AEROQUIP (CANADA) LTD., TORONTO 19, ONTARIO
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Aeroquip Corporation, Jackson, Michigan H&P-7
Please send me Bulletin No. 651 on new IRON MIKE Fittings and 1509 Hose.

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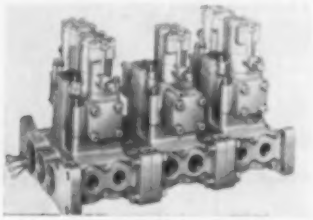
Title_____
Company_____
Address_____
City_____ Zone_____ State_____

NEW PRODUCTS

MULTIPLE MANIFOLD SUB-BASE

For manifold mounting of any combination of ¼" single or double solenoid, plug-in control valves. Gangs up to 10 valves in single unit. Each sub-base has common inlet, exhaust, and conduit ports, with provisions for O-ring seals. Connecting bolts permit end-to-end ganging of individual assemblies.



Specifications: Supplied with cylinder ports tapped ¾" or ¾" NPT, side or bottom connection. Common inlet and exhaust ports, 1" NPT. Optional pilot supply port, ¼" NPT. Common conduit port, with individual access cover in each sub-base, 1¼" NPT.—*Bellows-Valvair, Div. IBEC, Akron.*

Circle **305** on Reader Service Card

FLUID LEVEL SIGHT GAGE

For use with fire-resistant, synthetic hydraulic fluids. Contains reflector, gasket, window, glass gasket, frame, O-rings, nuts and bolts. Drill two holes to install. Mounting assemblies incorporate oil entry and air exit.

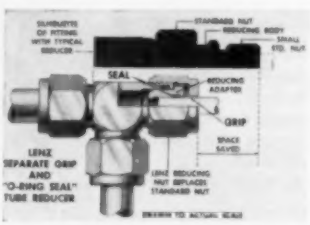
Specifications: Mounting bolt threads ⅜-13 for heavy or thin wall tank. Overall size 2" x 7". 5" between bolts. Bolts and frame cadmium plated.

Designation: Model 8575-NON.—*Century Hydraulics, Div. Century-Detroit, Detroit.*

Circle **306** on Reader Service Card

TUBE REDUCER

Uses separate collet grip and O-ring seal. Internal reducer bushing. One nut and sleeve eliminated. Split ring grips and locks tube. Shortens overall length.



Specifications: Sizes from 2" x 1½" to ⅜" x ¼" standard. Stainless steel. *The Lenz Co., Dayton, Ohio.*

Circle **307** on Reader Service Card

DEPENDABILITY

THESE HANDS MOLD precision hydraulic cylinder components. Their years of experience skillfully extract quality parts from raw stock—your guarantee of dependability. These adroit hands dare to test their skill with rigid, station-by-station inspection. Every cylinder conforms to the industry's highest standards. CROSS hydraulic cylinders are designed and built for varied, rigorous industrial applications. Write today for specifications. If it's not in stock, CROSS will customize a unit to fit your need.

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CROSS Engineers Available to You for Free Consultation!

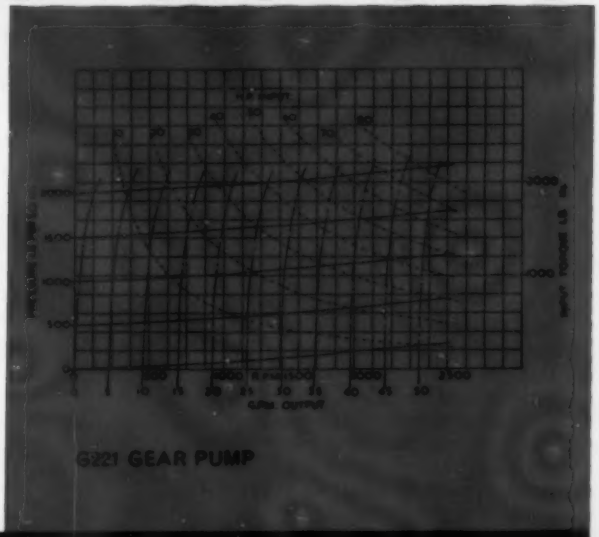
Circle **39** on Reader Service Card

For more NEW PRODUCT reviews turn to page 128

KEELAVITE
Hydraulics

GEAR PUMP / MOTORS

One of the new heavy duty gear pump/motors designed for high continuous rating.



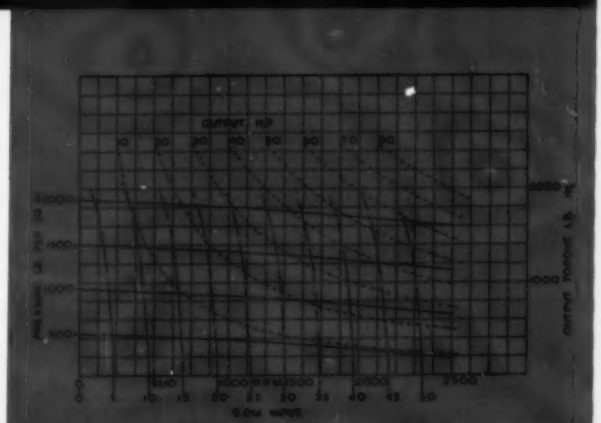
G221 GEAR PUMP

KEELAVITE GEAR PUMP/MOTORS

Within the wide range of the KEELAVITE G SERIES of GEAR PUMP/MOTORS, there is a unit suitable for any industrial use. Used as pumps, output ranges from 2.25 gpm. to 180 gpm. Motor torque ranges from 10.5 lb. ins. per 100 psi to 785 lb. ins. per 100 psi.

WHY THEY ARE BETTER

All of the KEELAVITE PUMP/MOTORS conform to a high standard of workmanship in manufacture, and are reversible without alteration in assembly. The whole range stems from six basic sizes and common components are used within each basic size. All units incorporate roller bearings.



G221 GEAR MOTOR

TYPICAL PERFORMANCE CURVES OF THE KEELAVITE G221 GEAR UNIT

THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

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Keelavite Hydraulics Ltd.,
Pieter de Hoochstraat 17
Rotterdam 6,
Holland

KEELAVITE HYDRAULICS LTD, ALLESLEY, COVENTRY, ENGLAND

Telephone: Meriden 441

NEW LITERATURE

Circle the numbers on the Reader Service post card for free copies

COMPRESSOR VALVES

Booklet gives valve requirements and function in compressors. Covers valving from mechanically-operated intake valves and heavy poppet discharge valves to high speed, air-cushioned valves. Section devoted to methods used in making modern valves. An assembly line is described and pictured. Cartoons and cut-away drawings illustrate valve components. 42 pages.—*Ingersoll-Rand Co., New York.*

Circle **400** on Reader Service Card

LEATHER PACKINGS

For all non-caustic, non-acid fluids. In oak, chrome, and combination tanned leathers. O.D. to 36". Brochure includes cups, U-packings, flanges, V-packings, washers, gaskets, and discs. Dimensions and prices.—*Auburn Mfg. Co., Middletown, Connecticut.*

Circle **401** on Reader Service Card

10,000 PSI PUMP DATA

Detailed pump and accessory data is given in individual catalogs. Vertical duplex and horizontal triplex pumps are covered. Pressures from 100 to 10,000 psi. Temperatures to 500 F. Wide range of capacities.—*John Bean Div., Lansing, Mich.*

Circle **402** on Reader Service Card

ROTARY-LINEAR ACTUATOR

Gives rotation, linear motion, or combinations of both. For rotation only, nonrotating piston moves in straight line, pushing spiral-male thread through threaded female shaft, which rotates. For linear motion only, pressure directly against shaft (with no pressure against piston) moves shaft outward, pulling piston along with it. For rotation and linear motion, pressure is applied to piston and shaft. Actuator for rotation only also available.—*Bachan Mfg. Co., Inc., Products Div., Madison Heights, Mich.*

Circle **403** on Reader Service Card

MOTOR PUMPS

A-c and d-c motor pump units are described in Bulletin 500. A-c units feature built-in check valve and adjustable relief valve. Piping in reservoir prevents external leakage. All cast aluminum. D-c units have detachable control valve, can be mounted remote from unit. Close tolerance needle bearing gear pump has built-in relief valve and check valve. Has three position valve, lift, positive hold, and release. Pressures to 1000 psi, 1750 rpm. Capacities from .5 gpm to 30 gpm. Bulletin 550 covers mobile equipment, d-c power units. Pressures to 2000 psi. Illustrations and dimensions given.—*Spencer Hydraulics Inc., Racine, Wisc.*

Circle **404** on Reader Service Card

HEAT EXCHANGER

For applications with high fouling fluids, needing frequent bundle cleaning, and where there are large temperature differentials between shell and tube side fluids, causing unequal expansions. Tube bundle is removable for cleaning. 19 shell sizes from 6" dia to 42" dia. 6 tube layouts of ¾", 1", and 1" tubes on both triangular and square pitch. 2, 4, and 6 tube pass arrangements. Pressures to 300 psi. Temperatures to 650 F. —*American-Standard Industrial Div., Detroit.*

Circle **405** on Reader Service Card

RULON & TEFLON PARTS

Booklet describes basic shapes and fabrications in Rulon and Teflon. Shapes include extruded rod, ⅛" to 2" O.D.; molded rod, 2" to 26" O.D.; extruded tubing, ⅛" to 1½" I.D., ¼" to 2" O.D.; molded tubing, to 26" O.D.; electrical sleeving; sheets from 1/32" to 2" thick; tape; and extruded shapes. Parts include O-rings, bearings, bushings, washers, packings, and retainers.—*Plastics Div., Dixon Corp., Bristol, R.I.*

Circle **406** on Reader Service Card

HEAT EXCHANGERS, AFTERCOOLERS, AIR FILTERS

Bulletin describes 15-, 10-, and 2-degree after-coolers. Counter flow design has air passing through tubes and water baffled back and forth across tubes in opposite direction. Handle 50,000 cu-ft air/min. Pressures to 1000 lb. Also shows shell and tube type heat exchangers made to fit any system. Details operation of Economat, which restores ⅛ of the compressed air lost in cooling process. Removes danger of oil-contaminated air and delivers air with a 20 F dew point. Complete data and prices on compressed air filters. Sizes ¾" to 4". Capacity 11 to 700 cu-ft/min. No. 715.—*R. P. Adams Co., Inc., Buffalo.*

Circle **407** on Reader Service Card

HYDRAULIC & PNEUMATIC TESTING

Brochure covers laboratory service and research facilities. Hydraulic equipment includes high pressure test stand, high pressure pumps, impact test stands. Static pressures to 100,000 psi, temperatures from −100 F to 1000 F.

Continued on page 60

NOW...

*1½" to 8" bores

There's an O-M *Cylinder for Every Purpose*

Meet JIC Standards

With the introduction of the new O-M Series "K," Square Head Air Cylinder, we can now supply the right air or hydraulic cylinders for your specific applications on low or high pressure systems. Ruggedly constructed of the highest quality materials, accurately machined to close assembly tolerances, O-M Cylinders operate with high efficiency and are quickly and easily maintained.

Whether your spec's call for a cylinder for a single operation or a variety of cylinders for a sequence of operations under continuous automatic cycling, there is an O-M Cylinder to meet your requirements. O-M Cylinders are individually tested at the factory and are available with standard or oversized rods, completely interchangeable parts and mounts.

Mail coupon TODAY for latest Bulletins showing construction and dimensional details, engineering drawings, capacity chart and mounting data.

ORTMAN-MILLER MACHINE COMPANY
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COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Circle **114** on Reader Service Card

Cellulube 220 was chosen for this hydraulic press when it was installed at North American in 1956. At that time it was used for form-die quenching of hot, fully expanded titanium parts at 1000°F.

...and since 1959, this same press has been used to form brazed stainless steel "honeycomb" panels for the B-70 bomber. The panels are pressure-quenched at 1700°F. Cellulubes are still safely on the job.

at 1000°F...or 1700°F...Cellulubes

FM Factory Mutual-Approved (Cellulubes 150 and 220)

Bureau of Mines—Approved #30-2

Celanese Chemical Company, Dept. 588-G, 522 Fifth Avenue, New York 36, N. Y.

Data on Cellulubes, please!

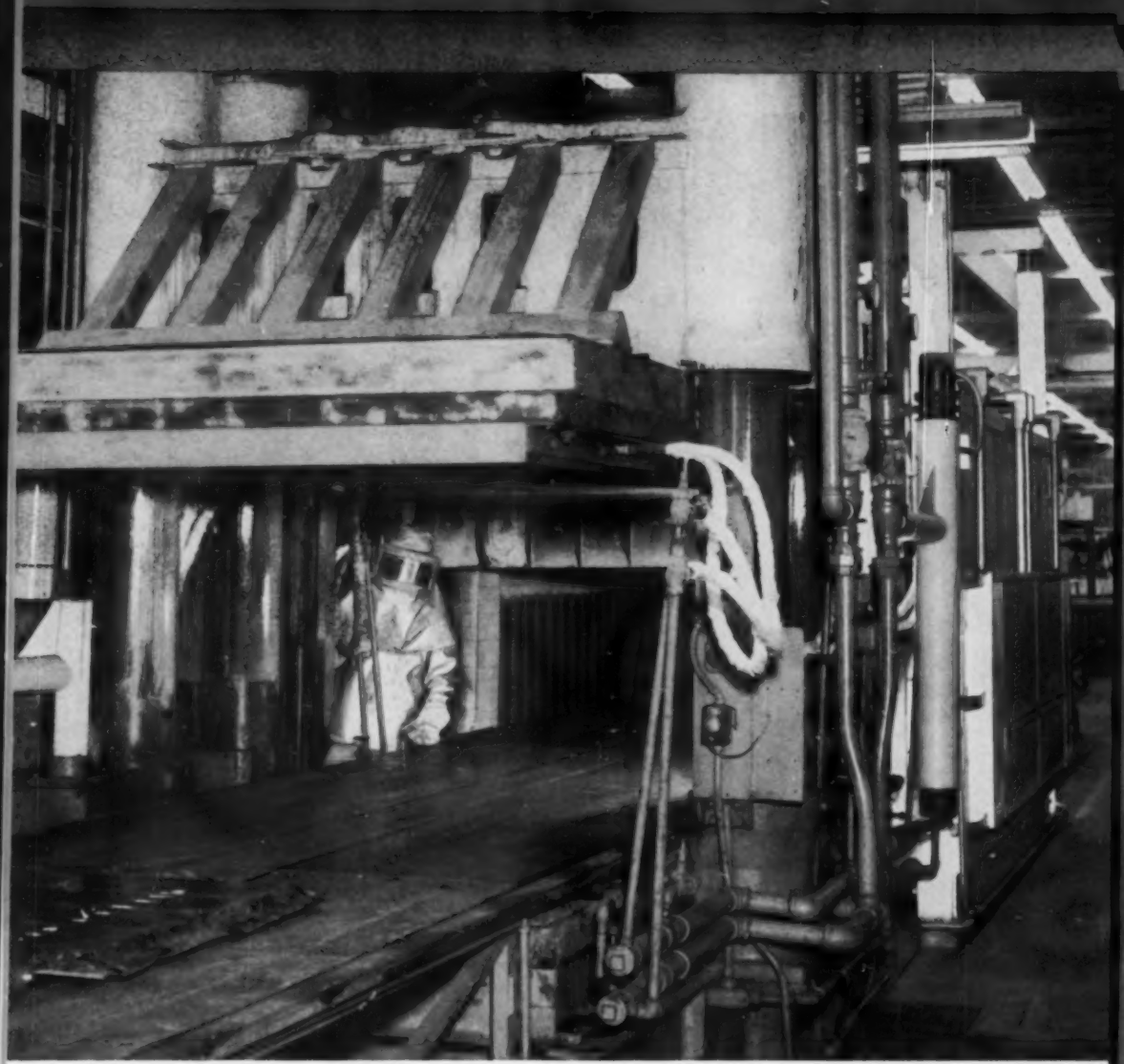
Name_____

Company_____

Address_____

City_____ Zone_____ State_____

Application I have in mind_____



guard safety at North American

In high-temperature press-forming operations like these, hydraulic line breaks could be a serious fire hazard. North American Aviation assures maximum protection for personnel and equipment by using Celanese Cellulubes—the *safe* hydraulic fluids. It's the best way to take the worry out of high-temperature production.

Perhaps you should be using Cellulubes, too! In addition to their safety advantages, Cellulubes provide overall protection against wear comparable to that of premium petroleum oils. There are no foaming problems, no additives to deposit in the system. Vapor pressure is extremely low; vapor losses negligible. And Cellulubes come in your choice of six viscosity ranges.

Mail the coupon for details, Celanese Chemical Company, 522 Fifth Avenue, New York 36, New York.

Celanese® Cellulube®

Cellulubes... Celanese CHEMICALS fire-resistant functional fluids

In Canada: Canadian Chemical Company Limited, 3035 Guy St., Montreal, Toronto, Vancouver • Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 522 Fifth Ave., New York 36

Circle **27** on Reader Service Card

CELANESE CELLULUBES

HIGH TORQUE at SLOW SPEED

Patent No. 2,881,171

New Char-Lynn Hydraulic ORBIT MOTORS® deliver Full Torque regardless of speed range

Even under normally critical conditions involving low RPM, Char-Lynn ORBIT MOTORS maintain maximum efficiency . . . and because these ORBIT MOTORS function as both a fluid displacement motor and gear reducer, no speed reduction devices are required.

Char-Lynn ORBIT MOTORS make possible unlimited hydraulic design opportunities for constant and variable speed drives, hydrostatic transmissions and remote controls.

- Speeds from 10—800 RPM
- Pressures to 2000 PSI
- Torques to 3000 lb. in.

WRITE TODAY FOR COMPLETE INFORMATION

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Circle **30** on Reader Service Card

NEW LITERATURE

Liquid flow at 30 gpm, 6000 psi and 50 F to 400 F. Surge cycling to 10,000 psi, impact cycling to 8,000 psi. Pneumatic static pressures to 12,000 psi, temperatures from −450 F to 2000 F.—*Flexonics Research Laboratories, Bartlett, Ill.*

Circle **408** on Reader Service Card

COUPLING, FITTINGS, VALVES

Catalog gives facts on automatic Safety-Lock, and regular quick-connect couplings. Tells best type used in handling air, oil, or grease. Information on chrome sleeve fittings for all types. Shows applications of couplers, fittings, hose, and 3-way sleeve valves to use with air-operated tools. Covers Handy-Air industrial blow gun with maximum volume control.—*Foster Mfg., Co., Inc., St. Louis, Missouri.*

Circle **409** on Reader Service Card

TEFLON USES

Teflon sheets, rods, tubes, and tape are made into end-use articles by machining to finished shapes. Booklet describes properties and uses of basic shapes and how they are made into finished pieces. Characteristics include heat, chemical, and moisture resistance; toughness and flexibility; and low friction. This allows use in rings, seals, packings, seats, plugs, sleeves, inserts, gaskets, bearings, pistons, and washers.—*Cadillac Plastic and Chemical Co., Detroit.*

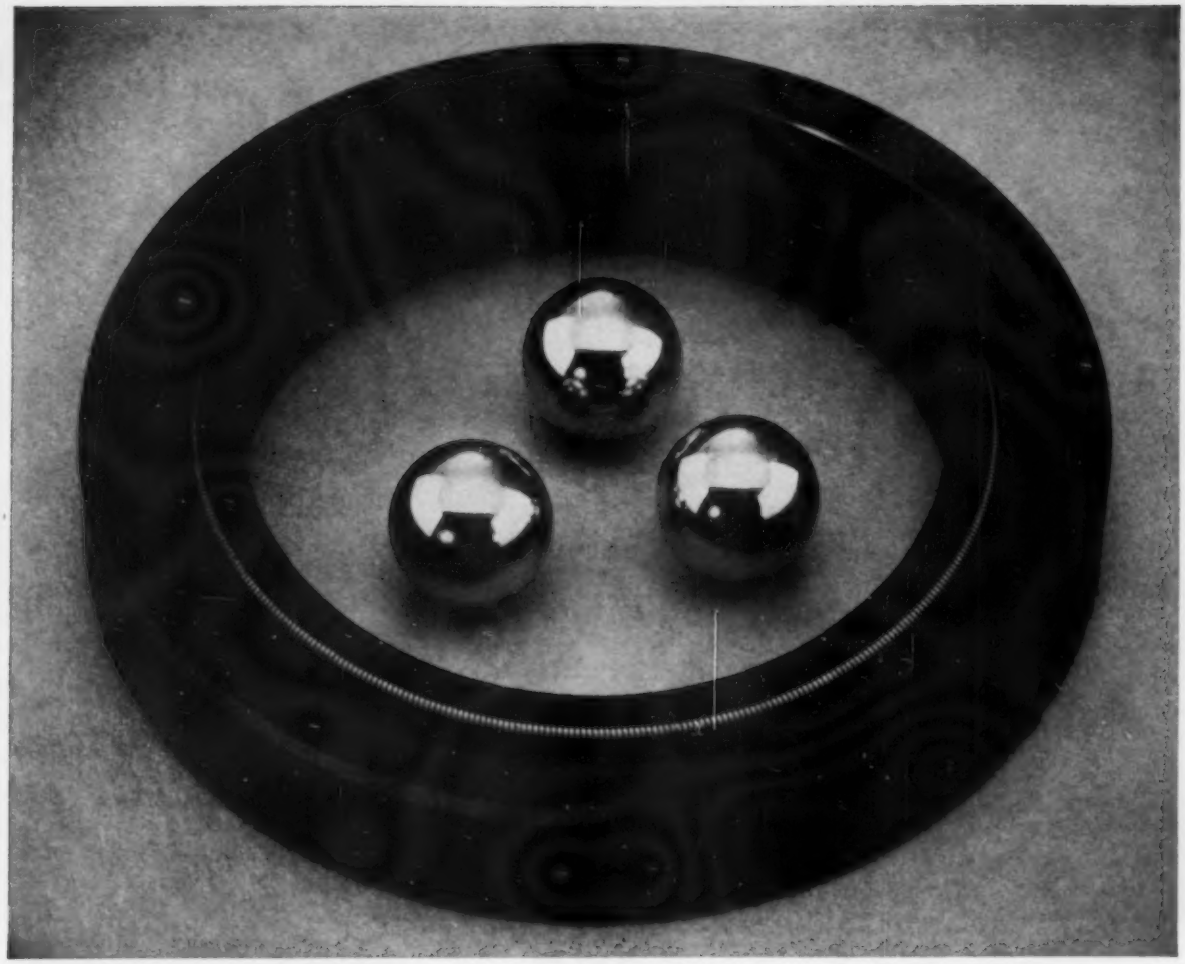
Circle **410** on Reader Service Card

ELECTROHYDRAULIC SERVOVALVES

Pictures and brief descriptions given of complete product line. Product Digest No. 160 gives general performance information on each valve.—*Midwestern Instruments, Inc., Tulsa.*

Circle **411** on Reader Service Card

For more reviews of FREE LITERATURE turn to page 138



Learn why J-M Clipper® Seals give you better protection for bearings

J-M Clipper Seals protect better because each is specially compounded to do its specific job. When you install the *right* Clipper Seal for your service conditions, it keeps lubricant in, seals out damaging dirt and grit . . . resists heat, speed and corrosive chemicals . . . gives you long, efficient protection. Here are the reasons why you can count on Clipper Seals for better service:

DUAL-COMPOUND CONSTRUCTION. A Clipper Seal consists of a soft, flexible lip and a tough, dense asbestos-compound heel, concentrically molded into one unit. There's nothing in a Clipper Seal that can rust, corrode or cause pitting of bore surfaces. In styles using a garter ring, even the spring is made of stainless steel.

DESIGN. J-M offers many design cross-sections to assure better protection and efficient sealing between regular overhauls.

SPECIAL MATERIALS. J-M will precision-mold Clipper Seals from materials that best suit your requirements. J-M is equipped to work with many materials: elastomers, including Du Pont Teflon . . . neoprene . . . silicones . . . and fluorinated, polyacrylic or other rubbers.

EASY INSTALLATION. Clipper Seals come away clean and easy. Replacement is fast, and requires no special tools or adhesives. You'll never have to scrape or refinish bore surfaces, because the compound heel protects the bore from damage. For quick, temporary replacement, Johns-Manville produces a special split seal.

SELECTION. Your J-M Distributor is a seal specialist. Just tell him your service conditions, and he will help you make exactly the right selection from J-M's wide range of designs, compounds and durometer stocks.

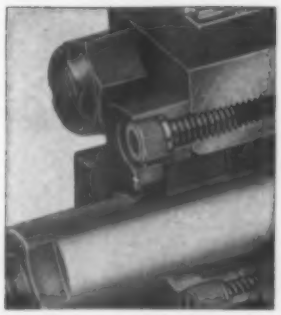
For complete information, see your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, address Port Credit, Ont.

JOHNS-MANVILLE
CLIPPER SEALS

JM PRODUCTS

Circle 83 on Reader Service Card

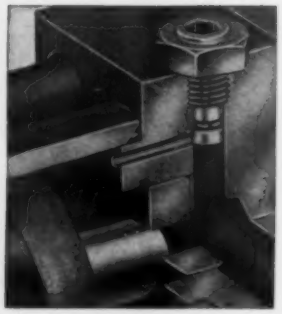
Do the cylinders you buy include these quality features?



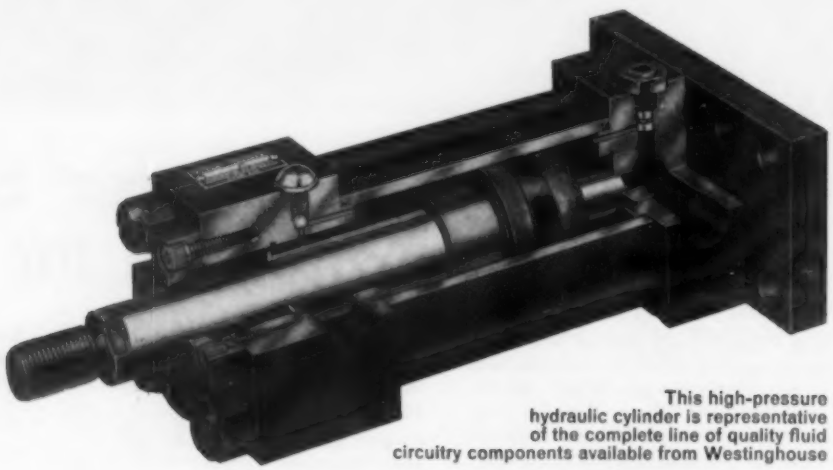
ROD GLAND—Easily removed. No need to loosen tie rods. Cuts maintenance time in half. Phenolic bearing insert will not score rod. Cuts replacement cost to a minimum.

ROD PACKING—Interlocking multiple lip seals require no adjustments; remain flexible under fluid pressure. Wear compensating function eliminates frequent replacement.

PISTON—Phenolic piston will not score tube. Packing cups used for proven long life and seal. Cups are easily replaced. Piston positively locked to rod.



CUSHION—Minimum clearance between piston and Meehanite Bushing combined with micrometer metering gives top cushioning efficiency and a wide adjusting range.



This high-pressure hydraulic cylinder is representative of the complete line of quality fluid circuitry components available from Westinghouse

if not, the chances are, your maintenance costs are higher than necessary. For more information about Quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A3-56.00.

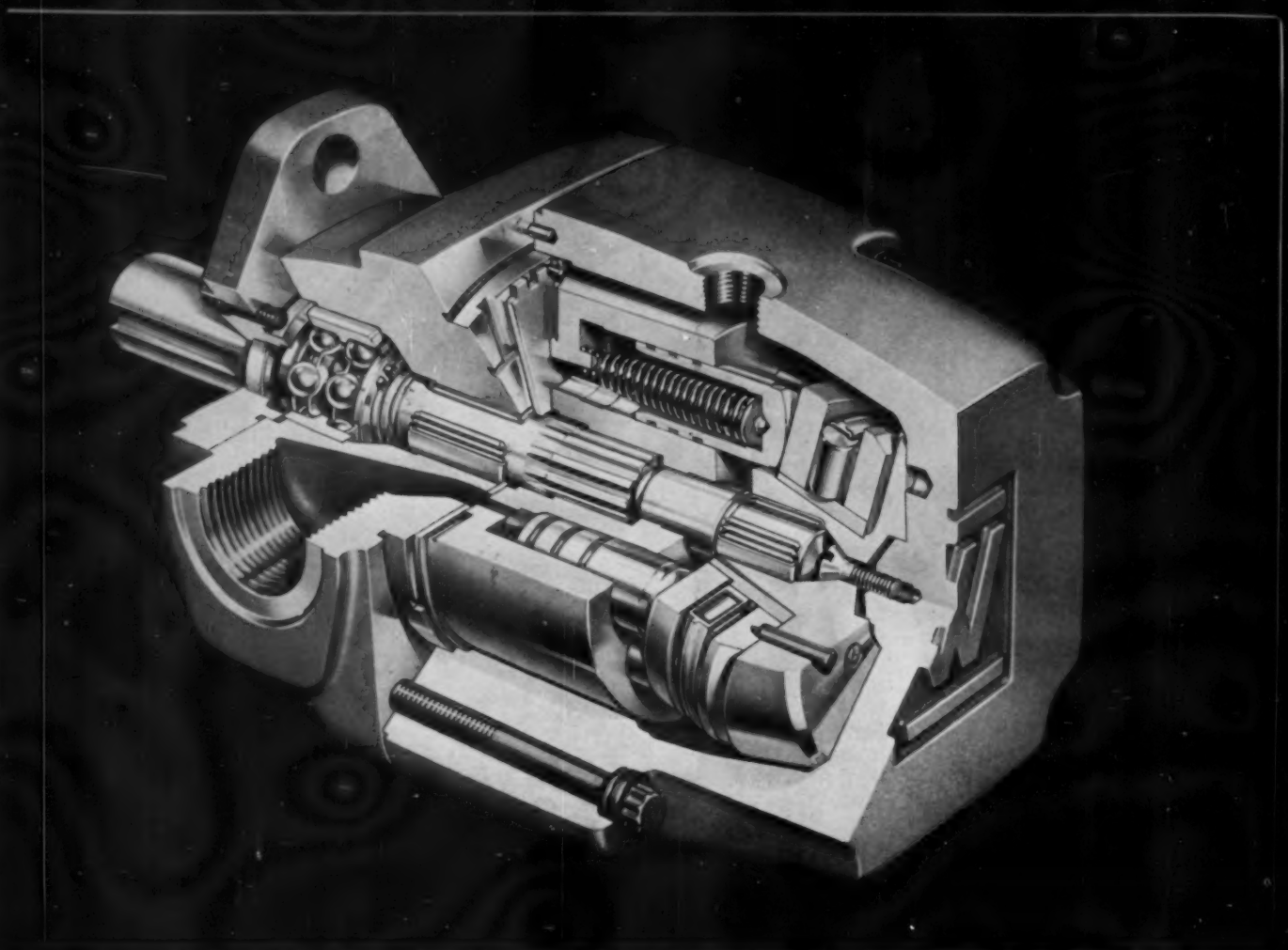
See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle **147** on Reader Service Card

Circle **146** ➔



WEBSTER'S NEW C3F PISTON MOTOR AND PUMP

compact, simple design ■ exceptionally serviceable!

This new hydraulic power unit — developed especially for the machine tool field — features unique application and servicing advantages. Examples: (1) small "package" to fit in close quarters — SAE "A" size mounting can be used with easy access to both mounting holes; (2) simplest axial-type piston pump on the market — fewest parts, fewer potential trouble spots, greater economy; (3) easily serviced — all critical moving parts can be readily replaced in the field. Shaft can be exchanged by disassembling seal end only; (4) unit can be disassembled and the rotation reversed in the field — can be arranged for use as a dual rotation motor; (5) variety of mounting styles — mounting plate and seal assembly is a separate piece and can be furnished in several mounting styles; (6) drive shafts are available with keyways or splines.

The C3F Series can be used as a hydraulic motor (remote rotary locations, screw feeds — anywhere an electric motor might be used) or as a hydraulic pump. . wherever high torque and smooth, steady force are required. It is available in four sizes — from .72 to 1.81 cubic inches per revolution. Capacities range from 3.3 to 8.5 gpm at 1200 rpm; 7 to 18 gpm at 2400 rpm.

C3F SERIES

FIXED DISPLACEMENT
AXIAL-TYPE PISTON
MOTORS AND PUMPS

Drive: direct, gear or belt

Displacements: four sizes; .72, 1.09, 1.45, 1.81 cu. in. per rev.

Porting: Side ports — horizontal or vertical — handle 1" NPT inlet or 1¼" "O" ring straight thread

Capacity: 3.3 to 8.5 gpm at 1200 rpm
7 to 18 gpm at 2400 rpm

Speeds: to 3000 rpm

Pressures: continuous duty 3000 psi, intermittent rating to 3500

When used as motor:

Torque range (theoretical): four sizes; 11.52, 17.28, 23.04, 28.80 inch pounds per 100 psi

Output: 5.5 to 14 hp. at 3000 psi at 1200 rpm
11 to 28 hp. at 3000 psi at 2400 rpm

OIL HYDRAULICS DIVISION
WEBSTER ELECTRIC
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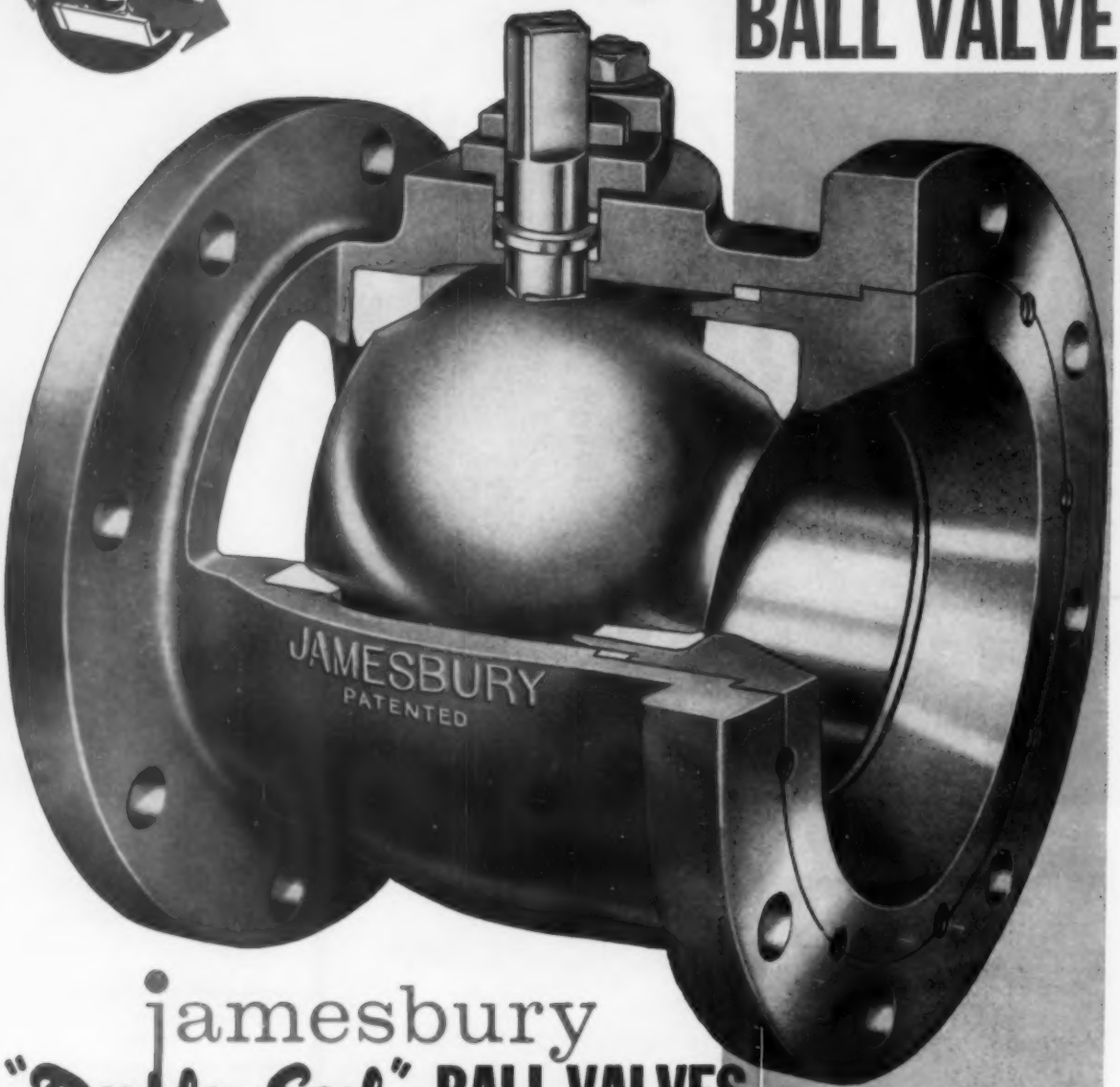
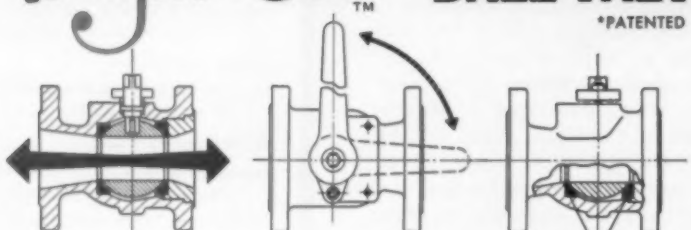
franklin adv. H127A

Close-up of Industry's MOST VERSATILE *BALL VALVE



jamesbury "Double-Seal"™ BALL VALVES.

*PATENTED



Full Flow — two ways | Quarter Turn Operation | "Double-Seal"

MATERIALS

Jamesbury "Double-Seal" Ball Valves are available in Types 303, 316 and Alloy 20 Stainless Steels, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Other materials on special order.

Interchangeable seats and seals are available in "Teflon", Nylon, Buna-N, Neoprene, Special Teflon compounds, and natural rubbers.

Pneumatic, Hydraulic and Electric Motor Operators to fit Remote Control Requirements.

SIZES

Screwed End: ¼" through 3".

Flanged:
150# series—½" through 12"
300# series—½" through 8"*
*10" and 12" on application
*600# series on application

Ask for complete "Double-Seal" Ball Valve Literature.

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Hydraulics & Pneumatics
JULY 1961

Have you ever felt after designing a pneumatic sequencing circuit that the system could be simpler with fewer components? Here's a new approach to air circuit design that assures accurate sequencing with a minimum number of components.

SIMPLIFY YOUR AIR CIRCUITS

• By **ARTHUR M. SALEK**, *Martonair, Ltd., Richmond, Surrey, England*

PNEUMATIC control circuits can be developed by following basic procedures. The resulting circuits will be reliable and have a minimum number of components. The method explained here does not depend on any proprietary type of equipment; in fact, the same principles may be used to design hydraulic or electric circuits.

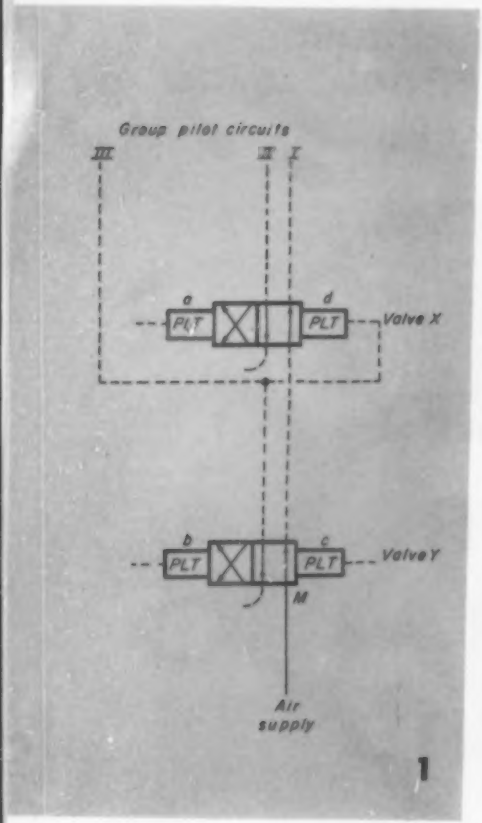
• **Circuit Elements**—Automatic, air sequencing circuits contain three basic elements. They are: functioning units, such as cylinders and air motors; controlling units such as pilot-actuated control valves or solenoid valves; and selecting units which determine the sequence, such as pilot valves, limit switches, or timers.

A versatile control valve for sequencing air circuits is the double impulse actuated control valve. This valve has air actuators at each end. It shifts when an air impulse is applied to one of the actuators. It remains in its actuated position when the impulse is removed. The actuator at the other end of the valve must be pressurized to return the spool.

Pilot valves are generally cam-actuated to one position, and returned by a spring. One of the important principles in circuit design is to provide each pilot valve with an air supply which is available only when needed.

• **Coding the Sequence**—To help analyze the sequence, each cylinder is assigned a letter (A, B, C, etc), and its movement designated by plus (extension) or minus (retraction). A sequence $A+$, $B-$, $C+$, $C-$, $B+$, $A-$ indicates a cycle where the first cylinder extends, the second retracts, the third extends and retracts, the second extends, and the first retracts. Time delays are also indicated in the code, and operations that are performed simultaneously are shown in brackets. The code might then become $A+$, $B-$, $C+$ (10 *sec. delay*), ($C-$, $B+$), $A-$, in which cylinder C remains extended for 10 seconds, then cylinder B extends while C is retracting.

• **Grouping Functions**—Reverse operation of a cylinder's stroke will appear in the code as a repetition of the cylinder's letter, with either a plus or a minus sign. If the cylinder is reversed by a double impulse actuated control valve, the pilot supply must be controlled so that pressure is not applied to both of the



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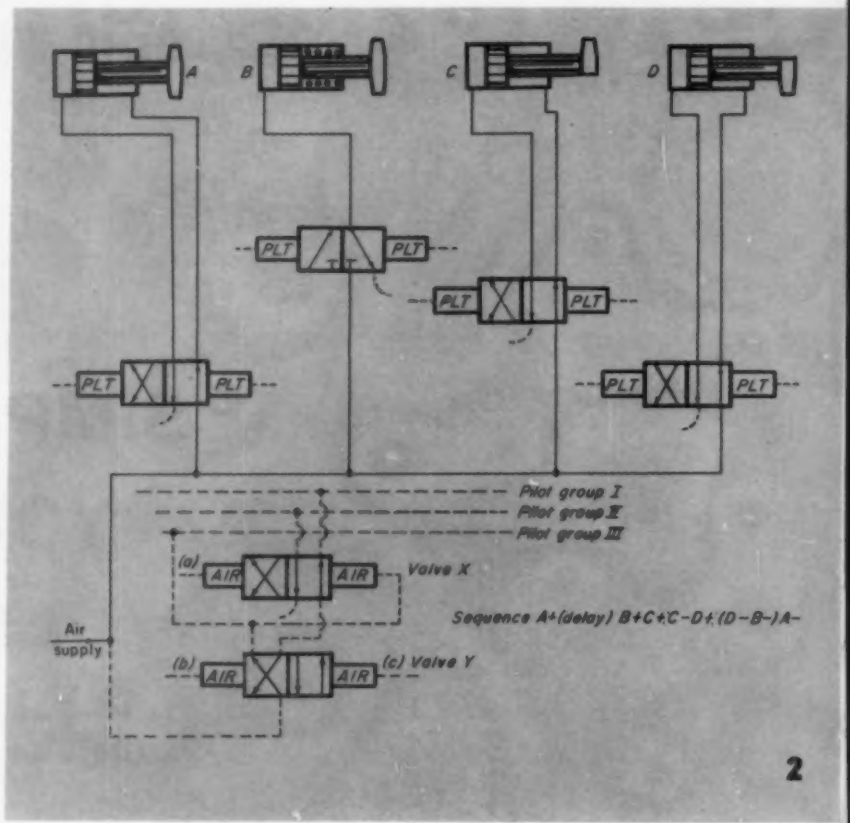

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valve's actuators at the same time. To prevent applying an impulse to one of the control valve's actuators before the impulse is removed from the other actuator, the sequences are divided into groups. If the coded sequence is split up so that a letter appears only once in a group, each group can be given a separate pilot air supply. This air supply can be automatically selected at the start of the group's sequence and removed at its completion. Each selected pilot supply provides all the actuating air for shifting the control valves in its allotted group.

Using the same example, the sequence would be grouped $A+$, $B-$, $C+$ (*delay*) : ($C-$, $B+$), $A-$: Groups I and II are separated with a colon.

• **Pilot Supply For a Three-Group Circuit**—Where three or more groups are involved, it is necessary to insure that each group's pilot signal is only effective when it is required. This prevents selecting a group out of sequence.

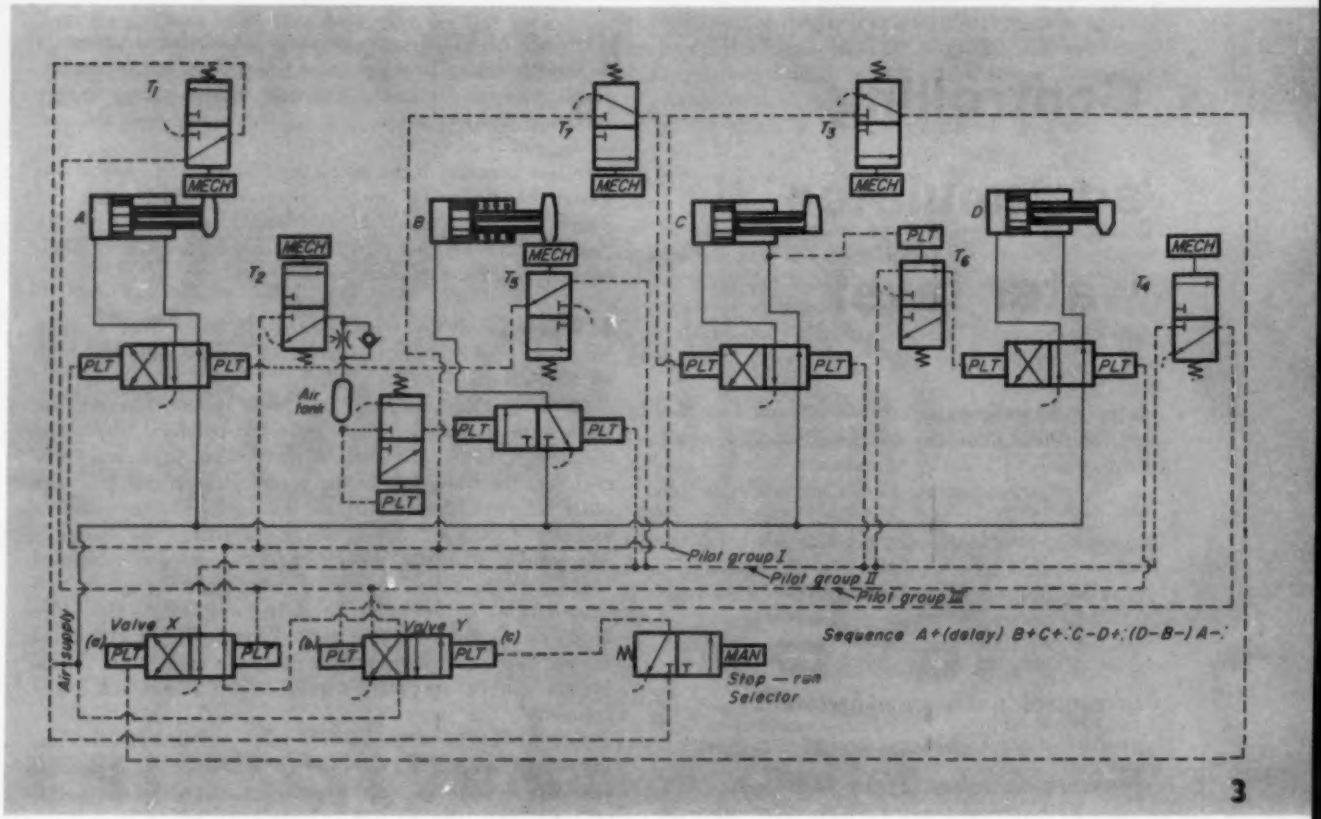
Two sequence circuits are required: one to extend and retract the cylinders, and the other to sequence pilot circuits. Three pilot supplies must be available for a 3-group circuit.

Two double impulse group selecting valves are connected in series, Fig. 1. Air supplied to port *M* feeds pilot circuit I. When an impulse is applied to actuator *a*, the air supply shifts to pilot circuit II, and circuit I exhausts. An impulse at actuator *b* directs air to pilot circuit III. This isolates valve *X* so that any impulse applied to actuators *d* or *a* will not direct air to circuits I or II. The connection from pilot circuit III to actuator *D* resets valve *X*. With valve *X* reset, an impulse at actuator *c* again provides air to pilot circuit I. Therefore, alternate impulses to actuators *c*, *a*, & *b* directs air to pilot circuits I, II, & III. These impulses are called selecting signals.

To select a particular group, the double impulse group selector valve should be shifted during the last operation of the preceding group and the signal canceled before the next group operation starts. To do this, the trip valve selecting the group receives air from the pilot circuit feeding the preceding group. In Figure 1, the signal to actuator *a* originates from group I, the signal to *b* from group II, and the signal to *c* from group III.

A group selecting, trip valve not only shifts the group pilot selector valve, but cuts off its own supply. It is self-cancelling. There is sufficient air expansion to shift the group selector valve after the trip valve shuts off. Hydraulic or electrical control circuits need separate methods to provide the pilot sequence.

• **Designing a 3-group Air Circuit**—Consider a sequence $A+$ (*delay*), $B+$, $C+$, $C-$, $D+$, ($D-$, $B-$), $A-$. This can be grouped $A+$, (*delay*), $B+$,



$C+ : C-, D+, : (D-, B-), A-$. No letter appears more than once in any group, regardless of sign. The steps required to draw the circuit are:

1. Each cylinder connects to a double impulse actuated control valve, Fig. 2. The three-group pilot arrangement from Fig. 1 is added to the circuit.

CASCADE SYSTEM

This building block method of air circuit design is called the Cascade System. It gets its name from the method of stacking pilot air supply valves. As the cylinder sequence progresses, pilot air for each group of operations is taken from the next lower valve in the stack.

2. In Fig. 3, the stop-run selector valve is placed so that it starts the cycle with a signal received from trip valve *T1*. *T1* is tripped at the completion of A— (end of previous cycle). It selects pilot group I by applying pressure to actuator *c* of valve *Y*. Because this is a group change signal, it must originate from the pilot circuit feeding the preceding group. Therefore, trip valve *T1* receives air from group III.
3. The first cylinder movement in each group is started by connecting the pilot circuit for that group to the proper actuator on the cylinder's control valve. Air applied to group I initiates *A+*, which trips *T2* starting the time delay. Air metered through a flow control valve into a storage tank gives the delay. *T2* and all other trip valves in group I receive air from pilot group I.
4. When *C+* completes its stroke, valve *T3* trips, applying air to actuator *a* on valve *X*. Valve *X* shifts, applying air to pilot group II and exhausting pilot group I. The first movement in group II is *C—* started by connecting air to group II pilot circuit. All trip valves in group II are supplied from this pilot circuit.
5. *D+* completes movements in group II and trips valve *T4*. This applies an impulse to actuator *b* of valve *Y*. Valve *Y* shifts, pressurizing group III pilot circuit. The first movements in group III, *D—* & *B—* operate simultaneously with this change. *B—* trips valve *T5* to retract *A* and trip *T1*. If the *start-run* selector is open, the cycle repeats. ▼▼▼

Controlling accumulator water level

• By J. C. GRIMSTAD
J. M. Grimstad Company, Milwaukee, Wisconsin

Numerous methods have been used to control water in a hydraulic system—manometers, magnetic floats, pressure switches. Here is a new, simple way that does the job well and inexpensively.

NON-SEPARATOR type, air-water accumulators present a serious design problem: how to keep air out of the hydraulic system. Air in the hydraulic system causes spongy operation and cavitation as the pump compresses air, and consequent heating.

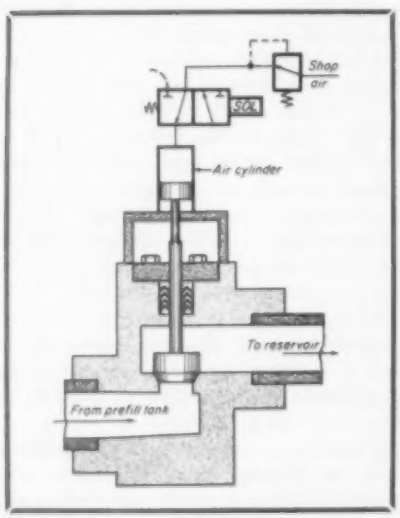
In one installation the problem of water level control was solved by designing special electrodes which were installed in the accumulator and prefill tanks. This design gives positive warning signals, control of pumps, and eliminates damaging, expensive breakdowns.

• **Water Level Control System**—In controlling accumulator water level, it is important to control both the high level and the low level.

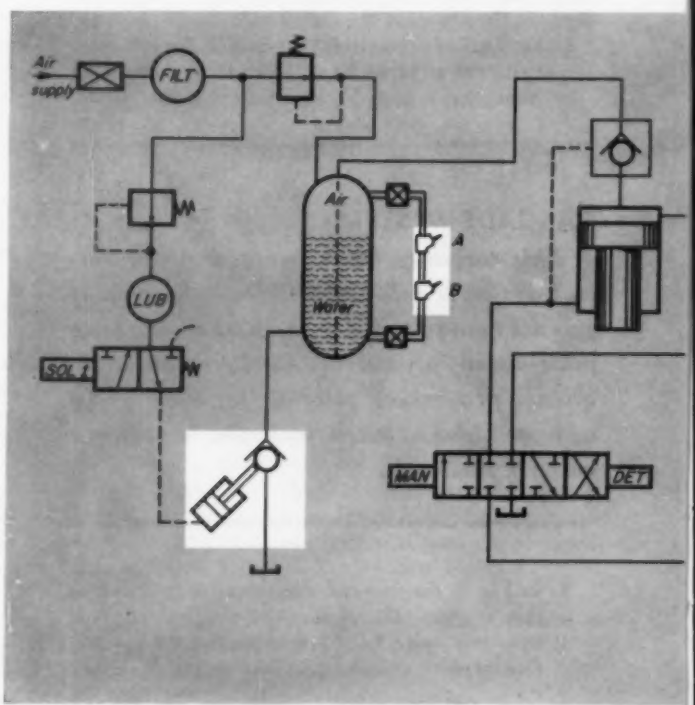
In the original design of this press system, warning signals were initiated by a delicately-balanced, weighted manometer. This circular, mercury-filled tube was connected to the water-side of the accumulator at one end. The other side was connected to a constant level water chamber and then to the air side of the accumulator. The assembly was pivoted about its center of gravity, and was calibrated for a specific set of operating conditions (pressure and temperature) by adjusting balancing weights. As the water level rose in the system, it shifted the center of gravity of the balancing mechanism. This made the manometer assembly rotate about its pivots, tripping a series of switches, and controlling the pumps.

The drawbacks to this method were that changing operating conditions had the tendency to unbalance the system. It was also difficult to build and maintain frictionless pivots that would not be affected by system vibration.

Other control methods had also been tried with limited success. Magnetic floats occasionally stuck in the ac-



DISCHARGE VALVE for prefill tank has an air cylinder which exerts enough force to close the valve tightly regardless of system contamination. In an emergency, the solenoid is energized, the air cylinder exhaust, and water from prefill tank drains to reservoir.



cumulator bottle. The low force signals they generated to swing the switch-tripping magnet were sometimes inadequate. Pressure switches, on the other hand, had a narrow range at the system's normal operating pressure of 4500 psi. Water level readings were often inaccurate.

• **Redesigned Water Level Controls**—In the new system, an auxiliary water column is attached to the accumulator and another to the prefill tank. Electrodes are mounted at proper intervals along the columns. The accumulator has electrodes for high and low level alarms as well as for actuating the system's three pumps at intermediate water levels. In the prefill tank, only high and low level warnings are necessary.

Each electrode is made from an ordinary automotive spark plug, mounted in a high pressure fitting. Each plug is backed with a heavy steel plate to withstand the system's 4500 psi pressure without leaking. When water rises in the water column and touches the spark plug's insulated contact, it completes an electrical circuit which actuates the proper valve.

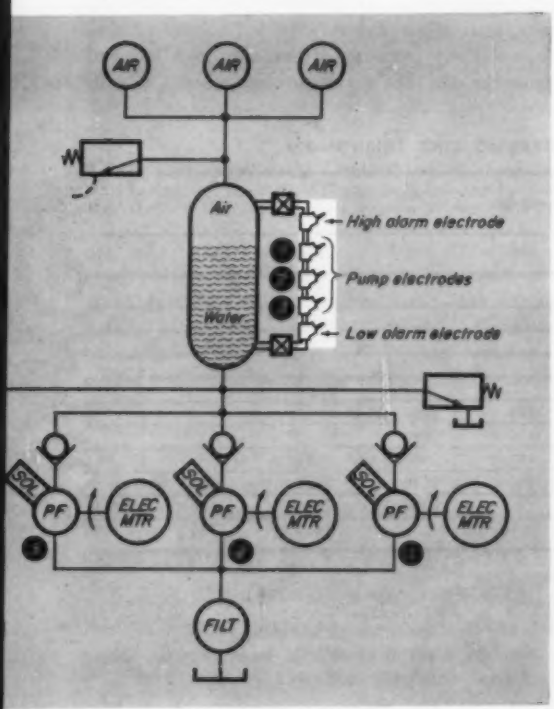
In the original design, air pressure had to be controlled closely to make sure that alarm and pump controls functioned properly. The new method maintains proper water level regardless of accumulator pressure. Maximum air pressure is needed only when the press must deliver maximum tonnage.

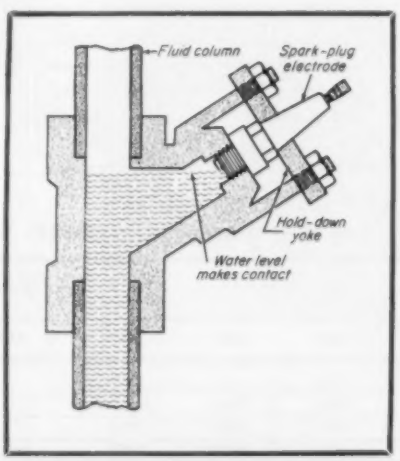
• **Pressure Actuated Valve For Prefill Tank**—The prefill tank must always hold enough water to fill the head end of the press cylinder. The purpose of connecting a discharge valve to the prefill tank as shown in the circuit is to drain off excess water. When the discharge valve is closed, it must seal tightly. A leaky valve can drain a prefill tank of all its water very rapidly. This would let air enter the water system. In float type discharge valves, the float usually exerts a force (to close the valve) equal only to the weight of the water the float displaces. Unless this is amplified, it does not hold the valve tightly closed, and the valve leaks. With the float valve method it is essential to maintain exceptionally clean water in the system. In a contaminated system, packing fragments on the valve seat will prevent the valve from sealing.

• **Piston-Actuated Discharge Valve Eliminates Leakage**—To overcome this problem, a conventional globe valve was reworked so it could be actuated by a small air piston, as shown in the drawing.

During normal operation, the small air cylinder closes the valve tightly regardless of system contamination. However, the cylinder force is slightly less than the force that would press on the bottom of the valve disc if it were exposed to emergency system pressure. In case of emergency or equipment failure, the discharge valve would open allowing water to drain to tank.

This design is economical and uses inexpensive, off-the-shelf components. Experience has shown that it is also safe, reliable, and efficient. ▼▼▼





ELECTRODE made from an automotive spark plug acts as a signaling device. When water level rises in the auxiliary column it makes contact with spark plug electrodes.

Last year in H & P's Fluid Power Forum readers outlined information they needed to use welded tubing for hydraulic line applications. This included metallurgy, surface finish, quality control methods, as well as dimensional specifications. This article was prepared by the Welded Steel Tube Institute to answer those questions.

Your guide to welded steel tubing

WHEN welded steel tubing was first developed, it was subjected to extensive and elaborate laboratory testing, where it underwent continuous vibration, pulsation, and shock loading. After it was proved in the laboratory, and in the field, a report was compiled by the Society of Automative Engineers' Committee on Tube, Pipe, Hose and Lubrication Fittings. This report was approved as an SAE standard in 1958. The JIC Hydraulic Standards revised edition of April 1959 adopted specification standards comparable to those approved by the SAE.

MANUFACTURING

• **Tube Forming**—Welded steel tubing starts as flat-rolled, carbon strip steel. The coiled stock is rolled to accurate gauge, and trimmed to the necessary width which will give the finished tube the proper dimension for close tolerance drawing. The flat stock is fed through driving rolls and polished forming rolls which gradually shape the strip steel into its final cylindrical form. Obvious surface imperfections can be detected during forming because the inside and outside surfaces are both open to visual inspection.

After the cylindrical shape of the tube is formed, side rolls apply pressure to the two butted edges as they are welded together electrically.

• **Welding Process**—The welding unit has two copper alloy, disc-shaped electrodes. When the tube passes under the electrodes, a high-amperage, low-voltage current is passed across the butted edges. The resistance to the flow of current across the joint causes intense localized heat between the butted edges. Under pressure from the side rolls, the edges are welded together. The side pressure that helps weld the joint also extrudes a small amount of metal on both the I.D. and O.D. These flashes are shaved off at once as the tube leaves the welding station. No foreign or additional material is added to the tube during welding.

• **Sizing and Heat Treat**—Welded tubing is usually made slightly oversize. Right after welding and flash removing, the tube passes through a series of rolls

CALCULATED WORKING PRESSURES FOR HYDRAULIC LINE TUBING—PSI

O.D. in.	Wall Thickness-in.									
	.035	.049	.065	.083	.095	.109	.120	.134	.148	.165
3/8	2800	3920								
1/2	2100	2940	3900							
5/8	1680	2360	3120	3990						
3/4		1960	2600	3320	3800					
7/8			2230	2850	3260					
1			1950	2490	2850	3270	3600			
1 1/4				2000	2280	2620	2880			
1 1/2					1900	2180	2400	2680		
1 3/4						1870	2060	2300	2540	
2							1800	2010	2200	2480
2 1/2								1610	1780	1980

This tables does not take into consideration surges or shock loadings, which may result in much higher instantaneous pressures in the tubing and the complete system.

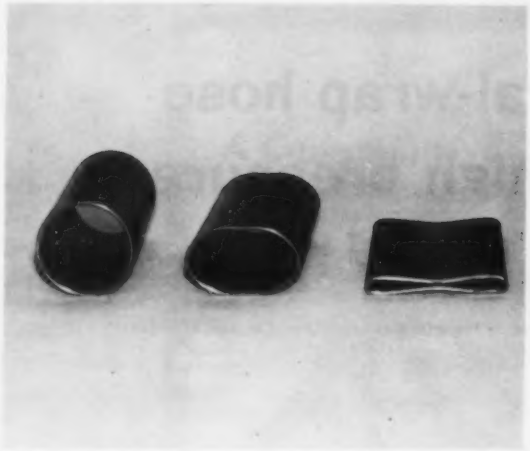
These values were computed from Barlow's formula:

$$P = 2ST/D$$

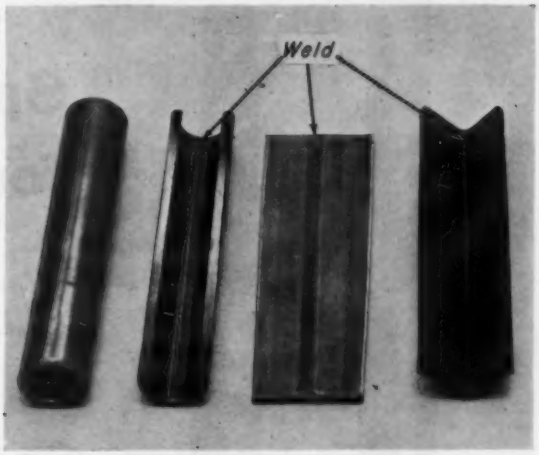
where P = Pressure
S = Fiber stress at 15,000 psi
T = Wall thickness
D = Outside diameter of tubing

For approximate bursting pressures, multiply these values by 3.3

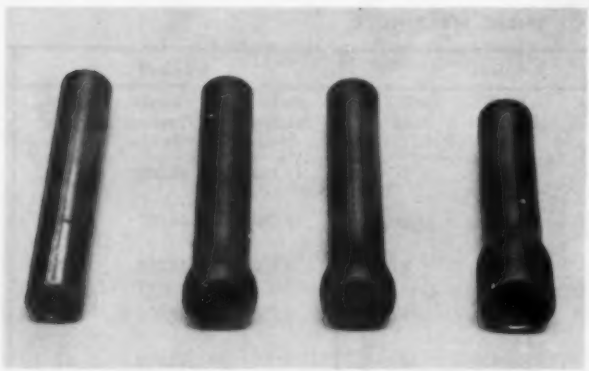
TESTS FOR QUALITY CONTROL



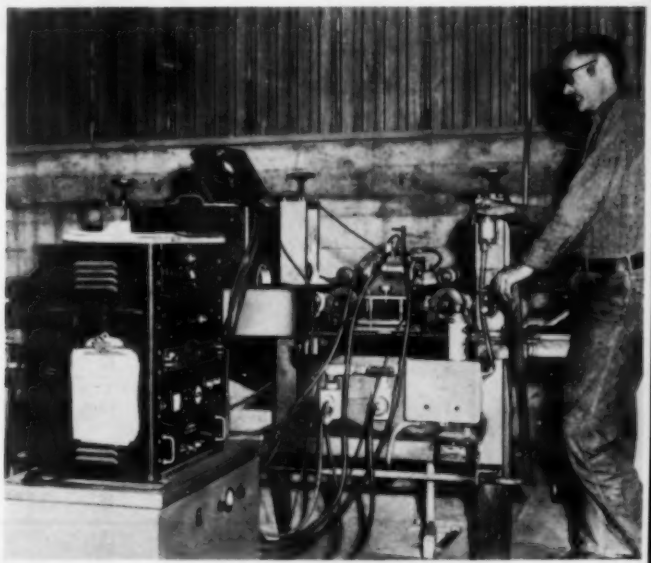
FLATTENING TEST compresses tube to three times its wall thickness. Tube weld is held at 90 degrees to direction of applied force. Evidence of cracks or flaws is cause for rejection. JIC standard test.



REVERSE FLATTENING TEST calls for tube to be split longitudinally 90 degrees on each side of the weld line, opened, and flattened with the weld at the point of maximum bend. There must be no evidence of cracks, overlaps, or lack of heat penetration. JIC standard test.



EXPANSION TEST stretches tube so that O.D. is increased a minimum of 25% in a minimum length of 1 inch. During expansion metal flow will magnify any surface defects. JIC standard test.



ELECTRONIC TEST inspects cold-finished, drawn-over-mandrel welded steel tubing electronically. JIC standards provide for a non-destructive electrical test approved by the purchaser in place of a hydrostatic test.

that cold reduce it to more exact size.

To insure ductility in hydraulic line tubing, the tubing is subjected to the following processing. It is normalized (to produce a finer, homogeneous structure by recrystallizing the metal grain) under controlled atmosphere conditions.

After tubing is cold drawn to final size, it is annealed to restore ductility. Cooling is under controlled atmosphere to minimize possible scale and oxides, and to insure uniform structure.

INSPECTION AND TESTING

In addition to the visual inspection made during the forming process, tubing undergoes a series of destructive and non-destructive tests in accordance with SAE and JIC specified standards. The following is part of the JIC standards relating to the tests that all hydraulic tubing must pass.

- **Flattening Test**—A section at least three inches in length shall be taken from every 1500 feet or less of finished tubing and shall be flattened between parallel plates to three times the wall thickness of the tube. The weld shall be placed at a point of 90 degrees from the direction of applied force. Any cracking or flaws revealed by this test shall be cause for rejection. Superficial ruptures resulting from minor surface imperfections shall not cause rejection.

- **Reverse Flattening Test**—A section at least four inches in length shall be taken every 1500 feet or less of finished tubing and split longi-

Continued on page 98

Spiral-wrap hose for high pressures

• By **ROBERT J. PETERMAN**
Assistant Director of Engineering,
Eastman Div. of Imperial-Eastman Corp., Chicago, Illinois

PRESSURE RATINGS OF SPIRAL WRAP HOSE

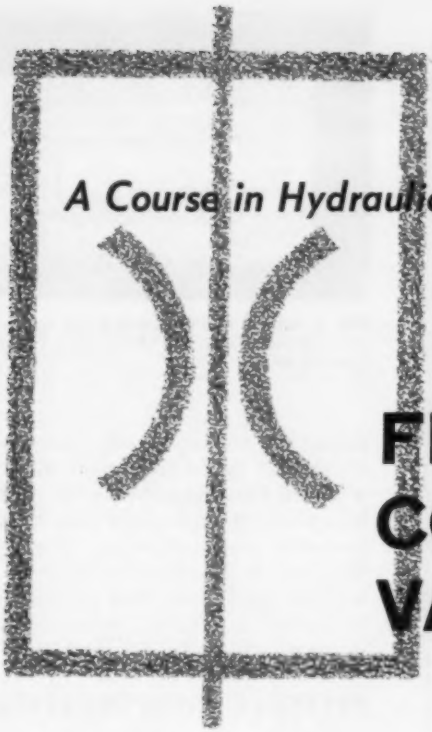
	2-Spiral 1 Braid			4-Spiral			6-Spiral		
Hose I.D. Inch	Working Pressure (psi)	Burst Pressure (psi)	Min. Bend Radii (in.)	Working Pressure (psi)	Burst Pressure (psi)	Min. Bend Radii (in.)	Working Pressure (psi)	Burst Pressure (psi)	Min. Bend Radii (in.)
1/4	7000	28,000	4	8750	35,000	5	11,250	45,000	5
3/8	5500	22,000	5	7500	30,000	6	10,000	40,000	6
1/2	5000	20,000	6	6250	25,000	8	7,500	30,000	8
3/4	4000	16,000	9 1/2	5000	20,000	10	6,250	25,000	10
1	3250	13,000	12	4000	16,000	12	5,000	20,000	12
1 1/4	2500	10,000	16 1/2	3000	12,000	18	3,500	14,000	18
1 1/2	2250	9,000	20	2500	10,000	22	3,000	12,000	22
2	2000	8,000	25	2500	10,000	27	3,000	12,000	27

HIGH pressure systems offer the hydraulic engineer many advantages. With higher operating pressures, components can be smaller and still deliver the required horsepower. Smaller components weigh less, can increase operating efficiency, reduce pressure drop in the system, and reduce costs.

In the past, designers were not able to use high pressure systems (3000 to 6000 psi) because adequate hose was not available. Hose has been developed recently that meets high pressure system requirements.

This high pressure hose gives excellent service life because of its spiral wrap, wire reinforcement design. This construction gives better impulse life than braided reinforcement hose. Impulse tests at the recommended working pressures for each hose size have run from 500,000 to well over 1,000,000 cycles. Failures in wire braid reinforcement frequently occur at the points of wire intersection. In contrast, wires in each layer of spiral wrap hose run parallel, and a thin layer of rubber separates each layer. Though heavier wire is used, spiral wrap hose is still quite flexible.

• **Fittings**—Permanently attached hose fittings with various thread ends, including SAE flange type, are made for 2-spiral wrap 1-braid, 4-, and 6-spiral hose. Crimping and swaging pressures required to attach fittings to spiral wrap hose exceed those used on SAE 100R1 and 100R2 hose. Two-piece, screw-type reusable hose fittings are available for the 2-spiral, 1-braid hose. The heavier reinforcements in the 4- and 6-spiral hose make the use of screw type reusable fittings impractical. Clamp type hose fittings can be used on the 4-spiral hose. ▼▼▼



A Course in Hydraulic Valves—PART 3

FLOW CONTROL VALVES

This article covers basic flow control valve design, performance, and function in a circuit. It will help circuit designers select the right valves for cylinder and fluid motor speed control. Previous articles in this series on directional and pressure control valves appeared in February and April issues of HYDRAULICS & PNEUMATICS.

IN MANY hydraulic circuits, velocity of a cylinder or fluid motor must be closely regulated. The quantity of fluid flowing to the cylinder or motor must be controlled to give this regulation. In circuits using a fixed displacement pump, the only method of regulating cylinder of fluid motor speed is with flow control valves. They are sometimes called speed control or flow metering valves.

These valves govern flow by restricting fluid movement in one or both directions. The restriction may be fixed or variable. In some elementary flow control valves, flow varies with changes in fluid line pressure. However, the more sophisticated ones compensate for fluid pressure and temperature fluctuations.

• **Needle and Globe Valves**—The simplest adjustable flow control valves are needle or globe valves. They have a threaded stem extending through the valve body or bonnet. In needle valves the stem is

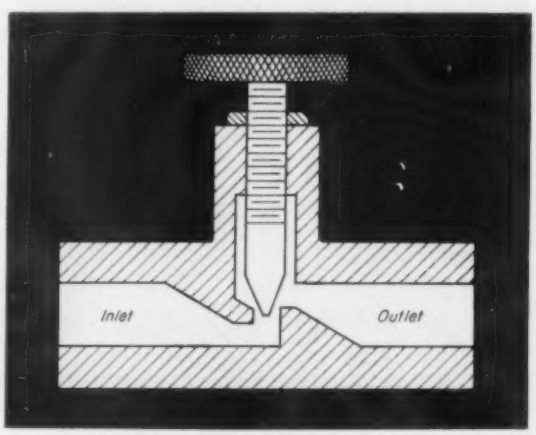


FIG. 1. NEEDLE OR RESTRICTOR VALVE regulates flow by moving pointed stem in or out of a fixed orifice. Flow varies directly with pressure drop across the valve.

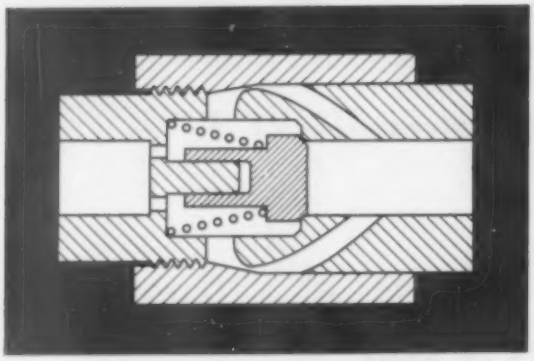


FIG. 2. ANNULAR ORIFICE is adjusted by rotating the valve body. The poppet lifts for free flow in the non-controlled direction.

pointed and flow varies by moving the pointed section in or out of an orifice in the valve body, Figure 1. This changes the area through the valve.

Flow through a globe valve is altered by moving a poppet attached to the stem with respect to a stationary seat. Flow through either globe or needle valves may be completely shut off.

Some needle and globe valves have a locknut on the stem that tightens against the valve body to hold the setting. These valves generally offer equal restriction to flow in either direction. However, some adjustable needle valves control flow in one direction and have an internal check valve that allows free flow in the other direction. These valves need no external check valve to permit reverse free flow when installed in cylinder lines.

To conserve space, some inline flow control valves have no stem. Flow through the valve in Figure 2 is changed by rotating the valve body. A vernier scale or a color code on the body shows the valve setting.

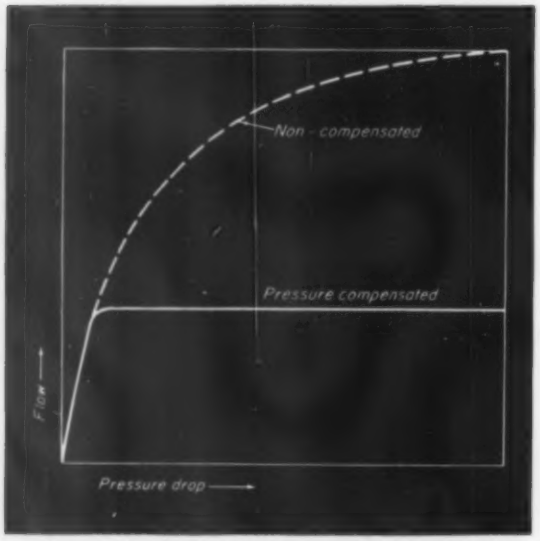


FIG. 3. PRESSURE-COMPENSATED FLOW CONTROL VALVE maintains constant flow although pressure drop across the valve varies. Flow through a non-compensated valve increases as the pressure drop increases.

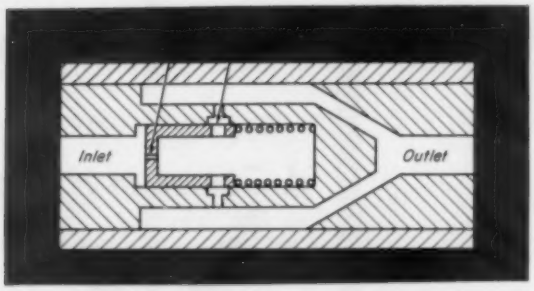


FIG. 4. INLINE FLOW REGULATOR compensates for changing inlet and outlet pressures by moving a poppet to open or close a control orifice.

• **Fixed Flow Regulators**—In fixed flow regulators, the opening through which fluid flows is generally an accurately machined orifice. This orifice may meter flow in both directions, or have an integral reverse free flow check valve. Flow through these valves, as in needle and globe valves, varies with the pressure drop across the valve.

PRESSURE COMPENSATION

Flow through an orifice or valve varies approximately as the square root of the pressure drop across it. Therefore any change in pressure at a valve's inlet or outlet changes flow through the valve, Figure 3. Some flow control valves have a means of compensating for pressure changes. To do this a constant pressure drop is maintained across a fixed or adjustable orifice in the valve. The pressure drop is maintained constant despite varying pressure upstream or downstream.

Figure 4 shows a pressure-compensated flow control valve with a fixed orifice. Pressure drop across the fixed orifice is kept constant by controlling pressure in the spring chamber downstream from the orifice. Flow through the valve is determined by the size of the fixed orifice. The control orifice pressure-compensates the fixed orifice by maintaining a constant pressure drop across it.

Increasing inlet pressure with constant outlet pressure moves the poppet so that it covers more of the control orifice. This movement restricts flow through the control orifice and increases pressure at the outlet of the fixed orifice. Decreasing inlet pressure moves the poppet to open the control orifice and decrease pressure downstream from the fixed orifice.

• **Bypass Flow Regulator**—A bypass flow regulator has a built-in valve that bypasses pump output which cannot pass through the flow regulator, Figure 5. For accurate regulation pump output must always be greater than flow through the flow control valve.

In operation, the poppet of the flow control valve in Figure 4 partly covers both the outlet and the tank ports. If inlet pressure increases, the poppet moves right, bypassing more fluid to tank and restricting the outlet port, increasing pressure downstream from the orifice.

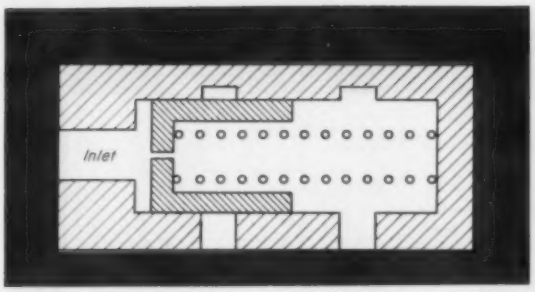


FIG. 5. BYPASS FLOW REGULATOR returns excess fluid to tank. While operating, the poppet covers part of the tank and outlet ports, maintaining a constant pressure drop across the orifice in the poppet.

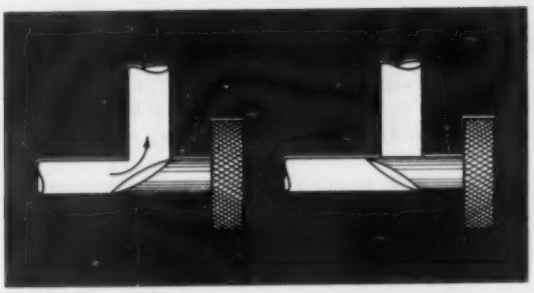


FIG. 6. ORIFICE AREA is varied by rotating a tapered stem. This gives full orifice opening in less than ½ revolution of the stem.

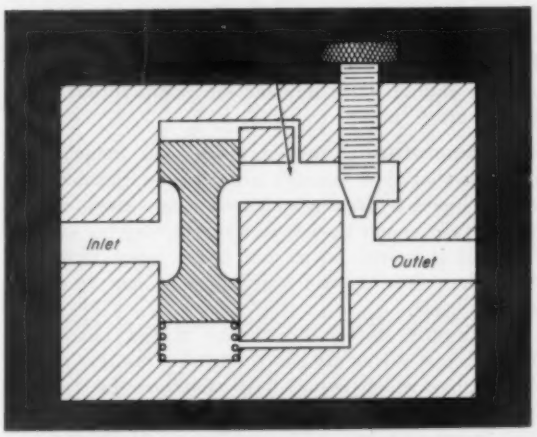


FIG. 7. PRESSURE-COMPENSATED, VARIABLE FLOW CONTROL VALVE gives constant flow with varying inlet and outlet pressures. Moveable spool is positioned by pressure from the control chamber and the outlet port, maintaining a constant pressure drop across the adjustable orifice.

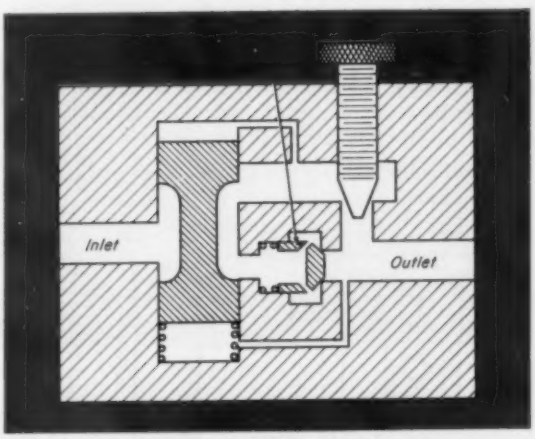


FIG. 8. REVERSE FREE FLOW CHECK VALVE in pressure compensated flow control valve allows unrestricted flow in the reverse direction. Check valve is needed if flow control valve is mounted between the directional valve and the cylinder.

If inlet pressure drops, the poppet moves left restricting flow through the bypass port and opening the outlet port. This movement decreases pressure downstream from the orifice.

A high surge pressure at the outlet port may close the bypass port completely. To protect the system from overpressure, a relief valve may be installed in the outlet line from the flow control valve.

• **Adjustable Flow Controls**—In most hydraulic systems, cylinder or fluid motor speed must be adjustable. To vary speed, flow control valves are made with variable orifices.

There are several methods of adjusting orifice area. One is a tapered slot on a shaft that changes flow area through the valve as the shaft rotates. Another uses a tapered shaft end that also changes orifice area as the shaft turns, Figure 6. These types of orifice adjustment give accurate control. They can adjust from shutoff to maximum area in less than ½ revolution of the shaft, with a calibrated dial for reset accuracy. Others cover a wider flow range with several revolutions of the shaft.

The adjustable flow control valve in Figure 7 maintains a constant pressure drop across the orifice by using an integral pressure compensating spool. The spool is positioned by sampling pressure upstream and downstream from the adjustable flow control orifice. The compensating spool moves to any required position to keep the pressure drop across the adjustable flow control orifice constant. As outlet pressure increases, the spool moves up increasing pressure in the control chamber. Increasing inlet pressure moves the spool down decreasing pressure in the control chamber. Orifice pressure drop is fixed by spring force.

• **Integral Check Valves**—If flow control valves are mounted upstream from directional control valves, any leakage in the directional valve alters regulated flow. To prevent this flow variance, flow control valves are generally located as close to cylinder or motor ports as possible. This arrangement gives accurate speed control but requires a check valve to allow free reverse flow when the cylinder or motor is reversed.

To avoid a separate check valve and its additional piping, some flow control valves are made with an integral check valve, Figure 8. During reverse flow, fluid entering the outlet port flows through the spring-loaded check valve and also acts on the bottom of the valve spool, holding it open.

• **Built-in Overload Relief Valve**—Some bypass flow control valves have an integral overload relief valve to relieve pump flow if downstream pressure

increases above the valve's setting. Only the pressure required by the cylinder or fluid motor is maintained at the valve. This reduces power input and heat loss when load on the cylinder or motor varies.

In Figure 9, position of the spool determines the pressure in the control chamber and the amount returned to tank. Pressure in the chamber on the bottom of the spool is limited by a relief valve. Fluid enters this chamber through a small port from the downstream side of the orifice. The relief valve is set to open slightly above the maximum pressure required by the cylinder or fluid motor. When the relief valve opens, the spool moves down and unloads the system.

A vent line from the chamber under the spool may be connected to tank through a shutoff valve. Opening the shutoff valve unloads the pump through the flow control valve.

• **Temperature Compensation**—Oil temperature changes alter flow through a fixed or adjustable orifice. When a hydraulic system is first started, its oil is generally cooler than it is after running for awhile. Cool oil is more viscous and has a lower flow rate through a flow control valve than it has after the system heats.

To compensate for this change in flow rate, some flow control valves use sharp edged adjustable metering orifices which reduce flow variations due to temperature and viscosity changes. Flow accuracies of 2% are possible with viscosity changes of 250 SSU.

A second method uses the principle of dissimilar metals expanding at different rates with increasing temperature. As oil temperature increases, flow area through the valve decreases. This is sometimes done by a tapered stem of high expansion metal expanding into a fixed orifice.

Temperature compensation can be a disadvantage when cylinder or fluid motor leak rates, increasing with temperature, are compensated for by similar increases in flow rates through the flow control valves.

• **Deceleration Valves**—Cylinders may be fitted with cushions at the ends of their stroke to reduce shock when they stop. These cushions are generally short because they are built into the cylinder end-caps. In some systems it is desirable to decelerate a cylinder before the end of its stroke or over a greater distance. Deceleration valves permit this gradual slow down.

Continued on page 78

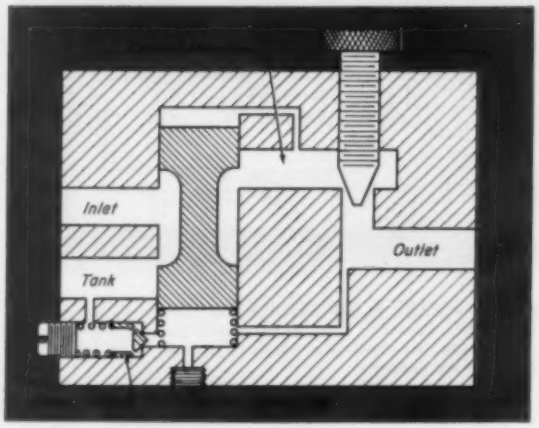


FIG. 9. INTEGRAL OVERLOAD RELIEF VALVE limits the flow control valve's maximum operating pressure. Valve permits unloading the pump by closing the adjustable orifice or opening the vent connection to tank.

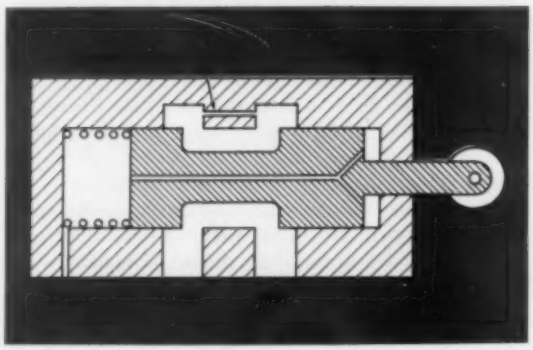


FIG. 10. DECELERATION VALVE gradually closes when a cam depresses the stem. Bypass orifice maintains a small flow to the cylinder when the valve closes.

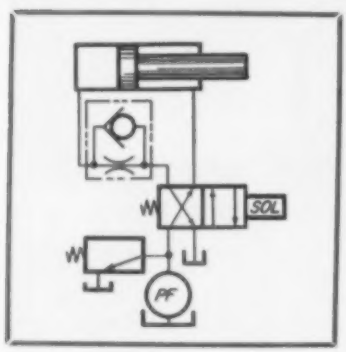


FIG. 11. METER-IN CIRCUIT regulates flow to the cylinder for speed control during the work stroke. Check valve allows free reverse flow when the cylinder retracts.

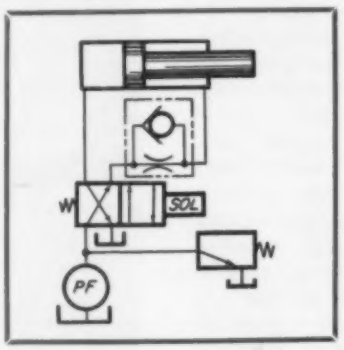


FIG. 12. METER-OUT CIRCUIT regulates flow from the cylinder for speed control. This circuit maintains a constant backpressure on the piston and prevents lurching if the load quickly drops.

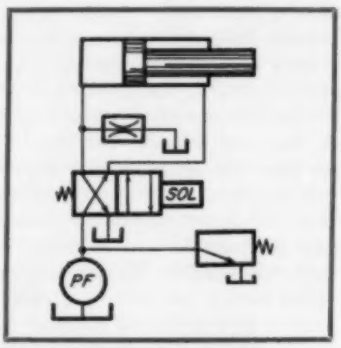
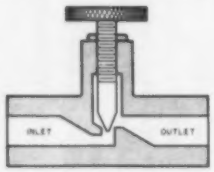
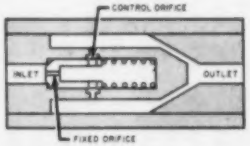
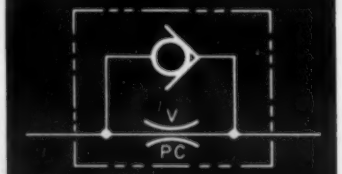
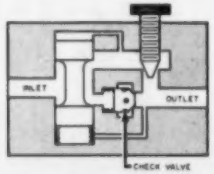
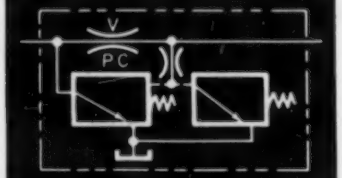
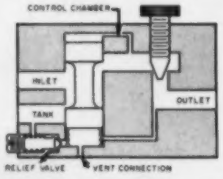
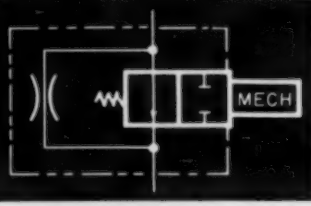
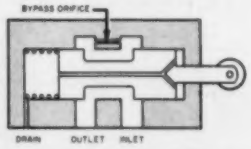


FIG. 13. BLEED-OFF CIRCUIT regulates flow to the cylinder by metering part of pump flow to tank. This circuit is more efficient than meter-in or meter-out because pump output pressure is only high enough to overcome work resistance.

HYDRAULIC FLOW CONTROL VALVES

NEEDLE OR RESTRICTOR			Restricts pump flow to or from cylinders or fluid motors. Flow varies with pressure drop across the valve. Used when system and load pressures are constant.
FIXED FLOW, PRESSURE-COMPENSATED			Regulates flow to or from cylinders or fluid motors. Flow rate is fixed by orifice size. Valve compensates for changes in system and load pressure.
PRESSURE-COMPENSATED, VARIABLE, WITH FREE REVERSE FLOW CHECK VALVE			Regulates flow to or from cylinders or fluid motors. Flow rate is adjustable. Can be installed between cylinder and directional control valve because integral check valve allows free reverse flow.
PRESSURE COMPENSATED VARIABLE, WITH OVERLOAD RELIEF VALVE			Regulates flow to cylinders and fluid motors. Pump flow not needed by cylinder or motor is bypassed to tank. Integral pilot relief valve prevents overpressure at outlet port. Used only in meter-in circuits.
DECELERATION			Meters flow from a cylinder near the end of its stroke to decelerate the load. May have integral check valve for free reverse flow. Actuating cam shape determines rate of deceleration.

FLOW CONTROL VALVES

These valves are normally open, cam-actuated, 2-way valves, Figure 10. As the cylinder reaches the point in its stroke where deceleration starts, a cam attached to the cylinder rod or tool slide gradually closes the valve, reducing flow from the cylinder. Deceleration valves are generally spool construction. Spool lands are machined so that they gradually reduce flow through the valve as the spool retracts. The lands may have a slight taper or a V-shaped notch to vary flow.

Deceleration valves may have a bypass orifice to allow a small flow when the valve closes. This flow gradually moves the cylinder against a positive stop. The flow may be fixed or adjustable. Some deceleration valves have an integral check valve.

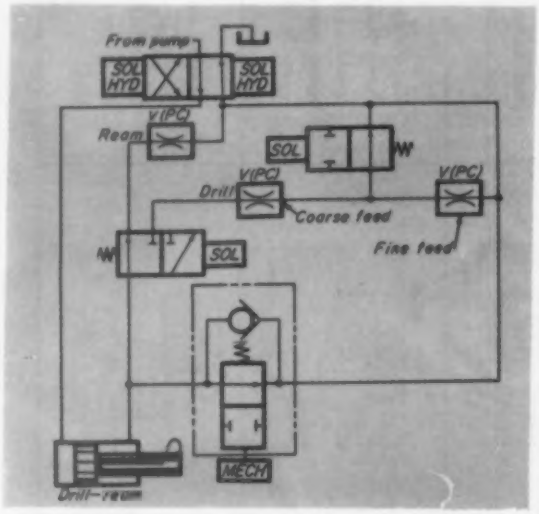


FIG. 14. DRILL-REAM CIRCUIT has four different cylinder speeds: rapid traverse, coarse drill, fine drill, and ream. Solenoid valves select flow control valves to meter fluid when the mechanically actuated 2-way valve closes.

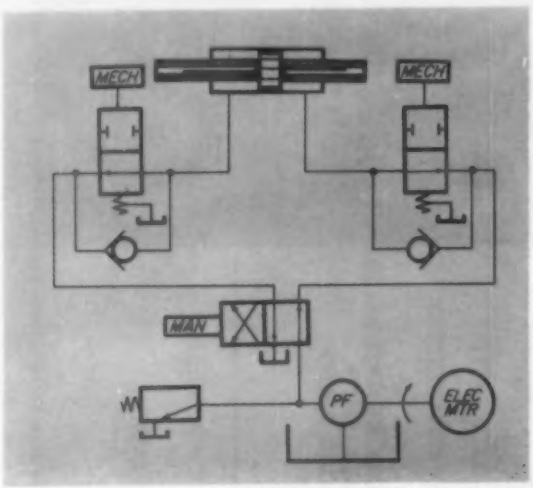


FIG. 15. DECELERATION VALVES gradually reduce flow from each end of the cylinder as it nears the end of its stroke. Check valves allow the cylinder to accelerate rapidly when flow is reversed.

• **Metering Circuits**—There are three basic methods of controlling cylinder or fluid motor speed. One is by metering fluid *to* the cylinder or motor, another is by metering fluid *from* it. The third method bleeds fluid to the reservoir from the pressure line.

The speed control circuit for a particular machine is determined by load characteristics of the cylinder or fluid motor. Certain control valves operate better in one circuit than another.

Meter-in circuits are used when the cylinder or fluid motor load is constant and always positive. If the load becomes negative (in the same direction as movement) the cylinder or motor jerks, because there is no fluid pressure holding it back.

Extending a cylinder with a meter-in circuit sometimes gives finer speed control than regulating flow from the rod end. The larger volume of fluid flow into the blind end permits more accurate flow control. Also, since the rod end is open to tank there is no danger of intensifying pressure in the rod end because of piston area differential.

Meter-in circuits are used on welding machines, grinder tables, and milling machines. Meter-in circuits should have a relief valve ahead of the flow control valve to return excess pump delivery to the tank. The relief valve may be incorporated in the flow control valve (such as a bypass flow regulator or a pressure-compensated flow control with overload relief).

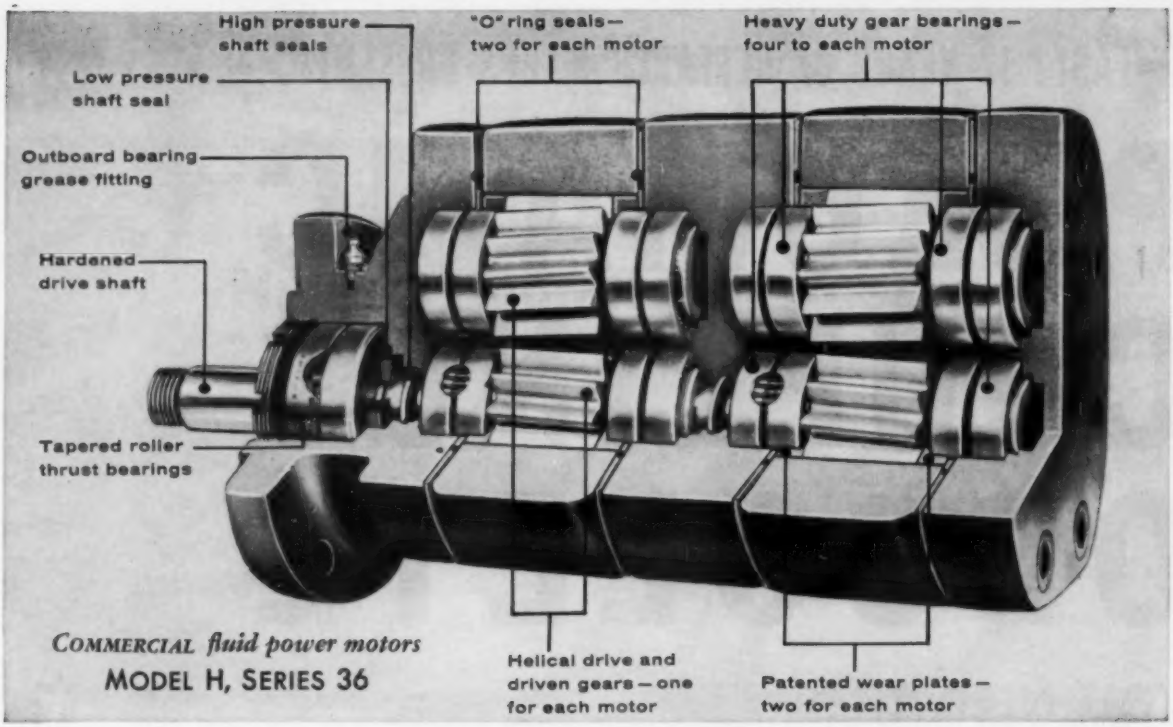
Efficiency of a meter-in circuit may be reduced because pump output not going to the cylinder or motor flows through a relief valve at full system pressure, unless the flow regulator has an integral bypass.

Meter-out circuits maintain a back pressure on the piston which prevents the cylinder from lurching when the load is quickly removed or becomes negative. Meter-out circuits are used for drilling, reaming, and boring.

If large cylinder rods are used and pressures are high, flow control valves in meter-out circuits should be protected with a relief valve. This limits pressure intensification at the rod end of the cylinder because of difference in piston area. Like meter-in circuits meter-out circuits are inefficient, because excess pump flow flows through a relief valve.

Bleed-off circuits are the most efficient, because system pressure is only high enough to overcome the work resistance. However, they do not compensate for varying pump flow as slip changes with pressure. Meter-in bypass circuits are also efficient for the same reason and are not affected by pump slip variations. These circuits are used for broaching machines, honing machines, and reciprocating grinder tables.

Flow control valves with built-in overload relief valves are not used on bleed-off or meter-out circuits, because they require pressure at their outlet port. With the outlet connected to tank, the integral relief valve would be held open, and pump output would unload to tank. ▼▼▼


High pressure shaft seals
"O" ring seals—two for each motor
Heavy duty gear bearings—four to each motor
Low pressure shaft seal
Outboard bearing grease fitting
Hardened drive shaft
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How to get multiple "speed-torque" output

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is help and assistance from COMMERCIAL's technical service department.

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Stability of a 3-way hydraulic valve depends on the balance of flow forces in the valve's null position. This article analyzes a theoretical valve. In a future article these principles will be applied to an actual valve design.

Null-position flow forces in 3-way servovalves

• By **HOWARD L. HARRISON,** *Associate Professor, Department of Mechanical Engineering*
University of Wisconsin, Madison, Wisc.

FLOW forces are produced by the flow of hydraulic fluid through metering orifices of a valve. 3-way servovalves react differently from 4-way valves. Flow force conditions in the null or center position are of particular interest, because the null position can be one of unstable equilibrium resulting in valve and system instability.

A control system using a 3-way servovalve is shown in Figure 1. With the valve spool in the null position, supply pressure P_s causes leakage flow across the center land of the spool to the return port. This leakage flow meets two equal restrictions at the metering edges of the center land, resulting in two equal pressure drops: cylinder pressure P_c is equal to one-half supply pressure P_s. Return pressure P_r equals zero. The cylinder piston remains stationary because it is hydraulically balanced: though P_c is one-half the supply pressure, it acts on the piston head end which has an area twice that of the rod end. The cylinder piston can be actuated by moving the valve spool to the right or left causing cylinder pressure P_c to decrease or increase accordingly.

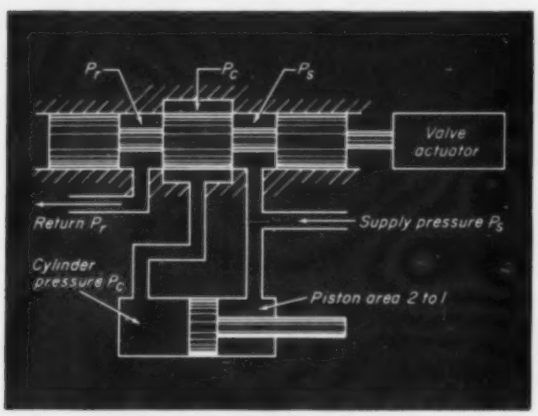

FIG. 1. IDEAL 3-WAY SERVOVALVE in null or center position. Piston head end area is twice that of rod end.

The valve configuration shown in Fig. 2 used to analyze flow forces, is for an ideal valve with square-edged orifices and zero radial clearance. It has an underlap y on each edge. Spool displacements x are considered from $-y$ to $+y$. The cylinder port is blocked to prevent load characteristics from influencing the valve which is assumed to be frictionless.

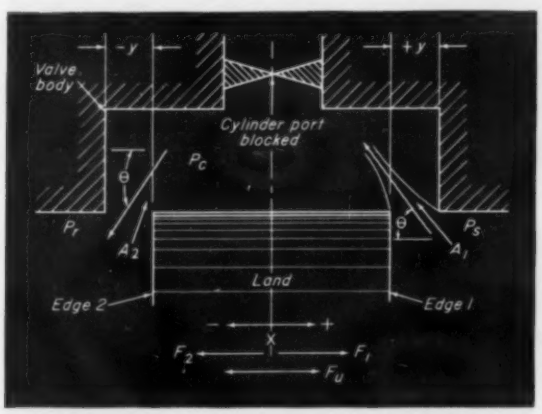

FIG. 2. VALVE CONFIGURATION has square edged orifices, zero radial clearance, and is assumed to be frictionless.

Flow force analysis is based on steady-state flow forces. Transient flow forces, for the limited displacements considered, are always equal in magnitude and opposite in sign, and therefore produce no net forces. Flow calculations are based on the work of Lee and Blackburn[1], who show that the basic equation (based on influx or efflux of momentum) for the axial component of flow force F at one edge of the square-edged spool is:

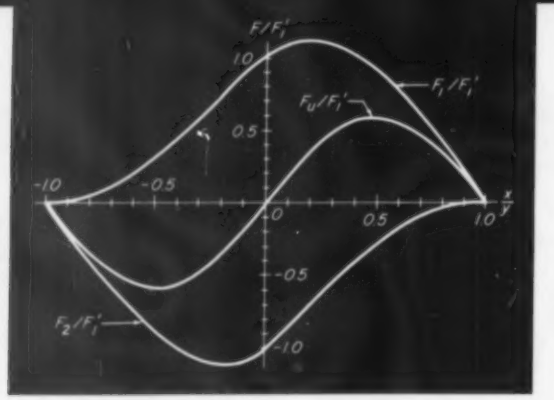

FIG. 3. IN NULL POSITION valve spool is in unstable equilibrium.

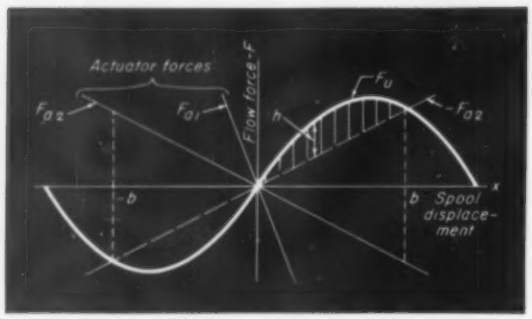

FIG. 4. IN UNBALANCED CONDITION, translation of the valve spool from the null position continues until static force equilibrium is reached.

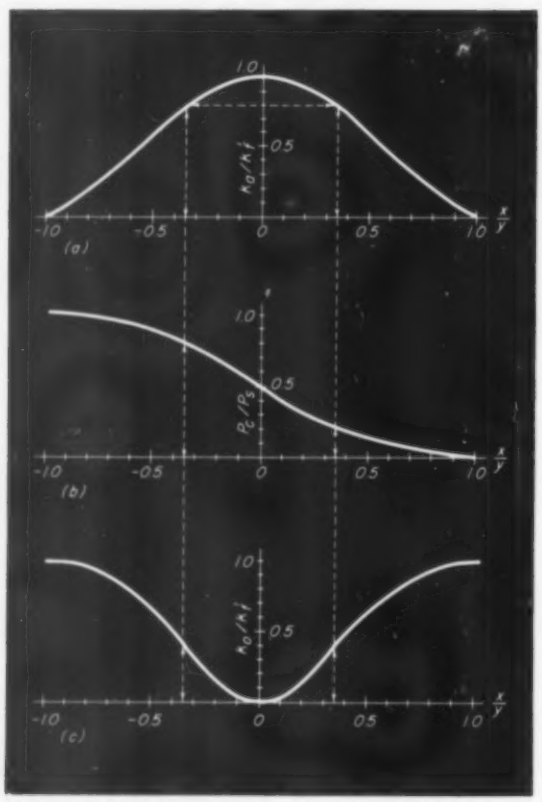

FIG. 5. CHARACTERISTICS of an unstable valve.

NULL-POSITION FLOW FORCES

$$F = Q\rho v \cos\theta \tag{1}$$

where: Q = total rate of flow
ρ = mass density of fluid
v = velocity of jet at vena contracta
θ = jet angle (69 degrees for ideal valve)

Force *F* always acts in the direction that reduces the valve opening regardless of the direction of fluid flow. Equation (1) becomes more useful when we substitute for velocity:

$$v = \sqrt{\frac{2\Delta P}{\rho}}$$

whe.e P is the pressure drop across the orifice,

$$F = \sqrt{2\rho}Q\sqrt{\Delta P}\cos\theta \tag{2}$$

It is assumed that flow is two-dimensional and that the fluid is non-viscous and incompressible.

The axial component of the flow force at edge 1 of the spool is designated as F_1, as shown in Figure 2. This force acting on the spool, tends to reduce area A_1 and represents a positive force for all displacements considered. In similar fashion, F_2 represents the axial component of flow force at edge 2. This force is negative. The algebraic sum of F_1 and F_2 represents an unbalanced flow force, F_u, which can be either positive or negative.

FLOW FORCE ANALYSIS

When return pressure P_r is zero, flow force F_2 is:

$$F_2 = -\sqrt{2\rho}\,Q\,\sqrt{P_c}\cos\theta \tag{3}$$

where: Q = rate of leakage flow
P_c = cylinder port pressure

Leakage flow *Q* can be determined by considering the two orifices A_1 and A_2 in series. Since flow is the same through both orifices:

$$Q = Q_1 = Q_2 = C_q A_1\sqrt{\frac{2(P_s - P_c)}{\rho}} = C_q A_2\sqrt{\frac{2P_c}{\rho}} \tag{4}$$

where: Q_1 = flow past edge 1
Q_2 = flow past edge 2
A_1 = area of orifice at edge 1
A_2 = area of orifice at edge 2
C_q = coefficient of discharge (assumed constant)
P_s = supply pressure

Solving equation (4) for cylinder port pressure P_c:

$$P_c = \left[\frac{1}{1 + \left(\frac{A_2}{A_1}\right)^2}\right]P_s \tag{5}$$

Combining equations (3), (4), and (5), flow force F_2 is:

$$F_2 = -2\,C_q P_s\cos\theta\,A_2\left[\frac{1}{1 + \left(\frac{A_2}{A_1}\right)^2}\right] \tag{6}$$

If spool displacements are assumed to be

$A_2 = w\,(y + x)$
$A_1 = w\,(y - x)$

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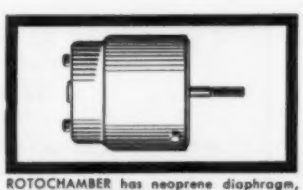

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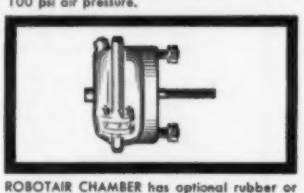

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NULL-POSITION FLOW FORCES

where: x = spool displacement
y = underlap per edge
w = peripheral width of orifice

then fluid force F_2 is:

$$F_2 = -2 C_q P_s \cos\theta \, w(y + x) \left[\frac{1}{1 + \frac{(y + x)^2}{(y - x)^2}} \right] \quad (7)$$

or

$$F_2 = -2C_q wy P_s \cos\theta \left[\frac{(1 + x/y)(1 - x/y)^2}{(1 + x/y)^2 + (1 - x/y)^2} \right] \quad (8)$$

Likewise flow force F_1 is equal to:

$$F_1 = 2 C_q wy P_s \cos\theta \left[\frac{(1 - x/y)(1 + x/y)^2}{(1 + x/y)^2 + (1 - x/y)^2} \right] \quad (9)$$

Unbalanced flow force F_u is the algebraic sum of F_1 and F_2:

$$F_u = 2 C_q wy P_s \cos\theta \left\{ \frac{x/y \, [1 - (x/y)^2]}{1 + (x/y)^2} \right\} \quad (10)$$

Based on equation (2), flow force F_1 with the spool in the null position is:

$$F'_1 = C_q wy P_s \cos\theta \quad (11)$$

Therefore:

$$\frac{F_1}{F'_1} = 2 \left[\frac{(1 - x/y)(1 + x/y)^2}{(1 + x/y)^2 + (1 - x/y)^2} \right] \quad (12)$$

$$\frac{F_2}{F'_1} = -2 \left[\frac{(1 + x/y)(1 - x/y)^2}{(1 + x/y)^2 + (1 - x/y)^2} \right] \quad (13)$$

$$\frac{F_u}{F'_1} = 2 \left\{ \frac{x/y \, [1 - (x/y)^2]}{1 + (x/y)^2} \right\} \quad (14)$$

Equations (12), (13), and (14) are plotted in Figure 3. F_u increases with displacement in a fairly linear manner, and its behavior is similar to a spring. The concept of flow force *spring rate* (which will be called *flow force rate*), is useful in considering valve stability. The magnitude of the rate at any point is equal to the slope of the curve at that point.

Figure 3 shows that the null position of the valve spool is a point of unstable equilibrium. Spool displacement in the positive direction results in an unbalanced positive flow force which tends to increase the positive deviation. A similar situation exists for negative spool displacements. In this case, however, the unbalanced flow force rate is negative in the sense that increased displacements produce forces which tend to increase the displacement.

Note that the presence of unbalanced flow forces will not necessarily produce valve instability: valve actuator characteristics are also important factors. Consider a single-stage electrohydraulic servovalve in which the torque-motor actuator, with no signal applied, exhibits a spring rate. The force required to move the actuator away from the null position is directly proportional to the displacement from that position. If the actuator spring rate exceeds the rate of the unbalanced flow force, the valve will be stable in the null position.

However, if the unbalanced flow force rate exceeds that of the actuator, the actuator cannot hold the valve spool in the null position, because the unbalanced flow force increases faster with displacement than the resisting actuator force. This unbalanced condition results in a translation of the valve spool from the null position. This continues until static force equilibrium is reached.

The unbalanced condition is illustrated in Fig. 4. If the valve actuator spring rate produces the line F_{a1} (F_a being the actuator force with no signal applied) the valve will hold the null position, because the slope of F_{a1} is greater than the initial slope of F_u. The restoring force is greater than the disturbing force. However, if the actuator characteristic is as shown by line F_{a2}, the actuator cannot hold the spool in the null position and the spool will seek position $\pm b$ where a force balance is achieved. This point of force equilibrium can be visualized by plotting line $-F_{a2}$.

A stable valve must be able to hold the spool in the null position and thus produce a cylinder port pressure P_c equal to one-half supply pressure P_s. This pressure relationship is required to hold the load cylinder motionless in any desired position. A valve that cannot hold the null position when used in a feedback control system requiring the positioning of the load cylinder is unstable and causes persistent fluctuations of the load cylinder and the system.

Continued on page 86

BEHAVIOR OF AN IDEAL 3-WAY SERVOVALVE

- Valve spool null position is a point of unstable equilibrium when only flow forces are considered. These flow forces combine to produce a non-linear hydraulic spring which has a negative rate, or scale. Any displacement from the null position results in a force that tends to increase the displacement. The value for the null position k'_f is calculated from equation (17).
- Flow force values for displacement within the underlapped region of the valve can be calculated from equations (8), (9), and (10) or from the dimensionless plot shown in Figure 3.
- A stable valve must be able to hold the spool in the null position. This means the valve actuator spring rate must exceed the null position flow force rate.
- A valve is unstable if flow force rate exceeds actuator spring rate. For this valve, equations (20), (21), and (23), or the dimensionless plots shown in Figure 5, can be used to determine the two possible stable displacements of the spool and, the corresponding values for the cylinder port pressure and effective overall spring rate.

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NULL-POSITION FLOW FORCES

FLOW FORCE RATE

The magnitude of flow force rate k_f in Figure 4, is equal to the slope of curve F_u:

$$k_f = \frac{dF_u}{dx} = \frac{F'_1}{y} \frac{d(F_u/F'_1)}{d(x/y)} \quad (15)$$

Differentiating equation (14) and substituting the value for F'_1 from equation (11), flow force rate k_f is:

$$k_f = -2 C_q w P_s \cos\theta \left\{ \frac{(x/y)^4 + 4(x/y)^2 - 1}{[1 + (x/y)^2]^2} \right\} \quad (16)$$

Flow force rate k'_f at $x = 0$, has a very practical use, because for stable operation, actuator spring rate k_a should exceed this value. The expression for k'_f is obtained from equation (16) by setting $x/y = 0$:

$$k'_f = 2 C_q w P_s \cos\theta \quad (17)$$

Equation (17), in which θ is equal to 69 degrees, is valid only for an ideal valve. Flow force rate for an actual valve with radial clearance is likely to be greater, because with radial clearance, jet angle θ varies with spool displacement[1]. This angle for a given spool displacement is least for the edge with the least underlap. Assuming a slight displacement from null, this results in a greater flow force unbalance than in the ideal case, and consequently a greater k'_f. Friction has been neglected in the analysis of the ideal valve. However, it is a factor which affects performance of an actual valve.

UNSTABLE VALVE CHARACTERISTICS

If flow force rate k'_f exceeds actuator spring rate k_a, the final displacement of the spool can be obtained by determining the point at which unbalanced flow force F_u equals actuator force F_a. Comparing equations (10) and (17):

$$F_u = k'_f y \left\{ \frac{x/y\,[1 - (x/y)^2]}{1 + (x/y)^2} \right\} \quad (18)$$

Actuator force F_a is:

$$F_a = -k_a x = -k_a y (x/y) \quad (19)$$

A force balance requires that the algebraic sum of F_u and F_a be zero. From equations (18) and (19), the expression for x/y is:

$$\frac{x}{y} = \left\{ \frac{1 - k_a/k'_f}{1 + k_a/k'_f} \right\}^{1/2} \quad (20)$$

Equation (20) is based on the assumption that $k'_f > k_a$. Cylinder port pressure P_c for a given spool displacement x/y can be determined from a modified form of equation (5):

$$P_c = \left[\frac{1}{1 + \left(\frac{1 + x/y}{1 - x/y} \right)^2} \right] P_s \quad (21)$$

In Figure 4, ordinate differences h (within the shaded area) represent unbalanced forces which act to accelerate the valve spool and the connected masses. Thus, the spool tends to overshoot point b with resultant oscillation. The overall effective spring rate k_o that exists at point b is, for all practical purposes, the sum of actuator rate k_a and flow force rate k_f existing at this point. Thus:

$$k_o = k_a + k_f \quad (22)$$

or

$$\frac{k_o}{k'_f} = \frac{k_a}{k'_f} + \frac{k_f}{k'_f} \quad (23)$$

Solving for k_a/k'_f from equation (20)

$$\frac{k_a}{k'_f} = \frac{1 - (x/y)^2}{1 + (x/y)^2} \quad (24)$$

Since flow force rate must be considered equivalent to a negative spring rate, the sign of flow force rate must be changed before summing it with a positive spring rate. Combining equations (16) and (17) with the required sign change:

$$\frac{k_f}{k'_f} = \left\{ \frac{(x/y)^4 + 4(x/y)^2 - 1}{[1 + (x/y)^2]^2} \right\} \quad (25)$$

Substituting equations (24) and (25) in equation (23):

$$\frac{k_o}{k'_f} = \left\{ \frac{4(x/y)^2}{[1 + (x/y)^2]^2} \right\} \quad (26)$$

Equations (20), (21), and (26) are plotted in Fig. 5 as curves *a*, *b*, and *c*. For a given value of k_a/k'_f curve *a* gives the two possible stable spool displacements. For these displacements, curve *b* gives the corresponding cylinder port pressures, and curve *c* the values for the effective overall spring rate to be used in determining the frequency of any fluctuation. ▼▼▼

SYMBOLS

A	Orifice area
C_q	Coefficient of discharge (assumed constant)
F	Flow force
F'	Flow force with valve spool in null position
F_1	Axial component of flow force at edge 1
F_2	Axial component of flow force at edge 2
F_u	Unbalanced flow force
F_s	Actuator spring force with no signal applied
k_a	Actuator spring rate
k_f	Flow force rate
k'_f	Flow force rate with spool in null position
Q	Flow
P_c	Cylinder port pressure
P_r	Return pressure
P_s	Supply pressure
v	Velocity of jet at vena contracta
w	Peripheral width of orifice
x	Spool displacement
y	Underlap per edge
ΔP	Pressure drop across orifice
ρ	Mass density of fluid
θ	Jet angle (69 degrees for ideal valve)

REFERENCE

1. Lee, S. Y. & Blackburn, J. F., "Contributions to Hydraulic Control—1—Steady-State Axial Forces on Control-Valve Pistons," ASME Trans., v. 75 n. 6, Aug., 1952, pp. 1005-9.

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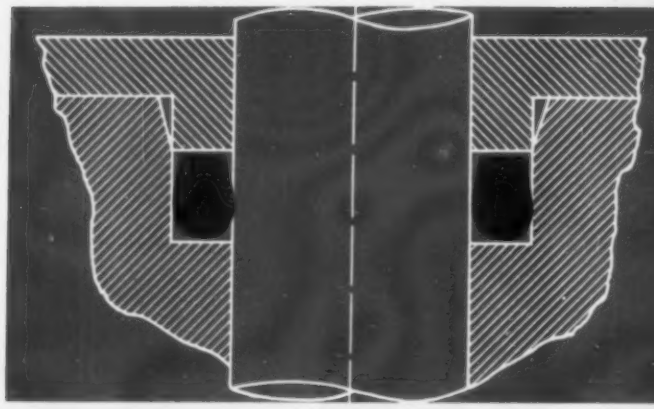

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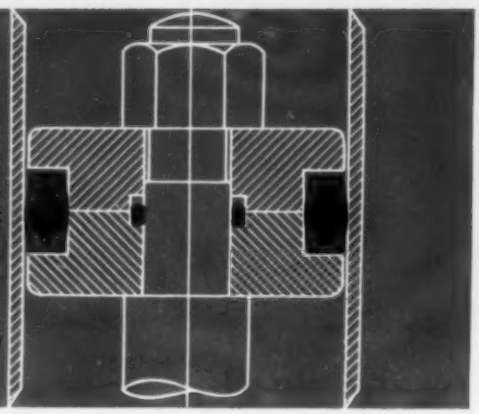

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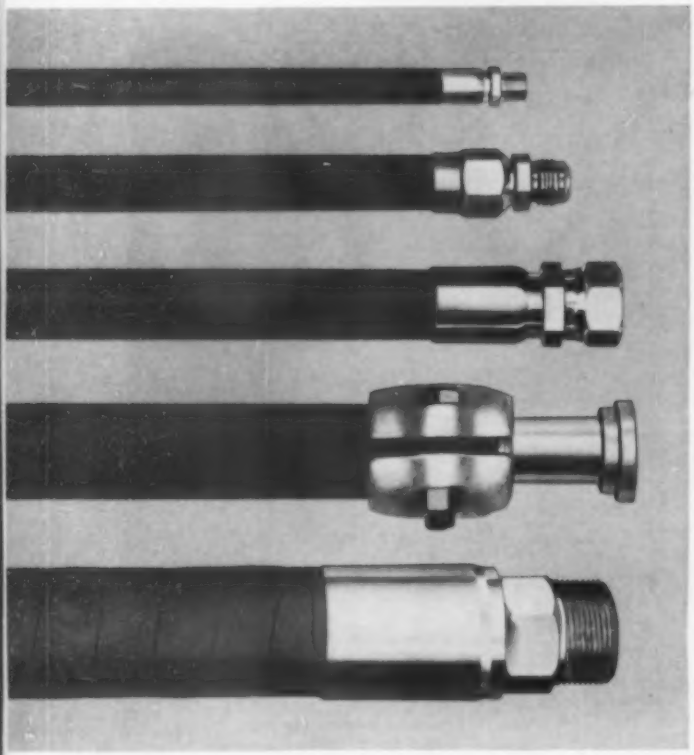

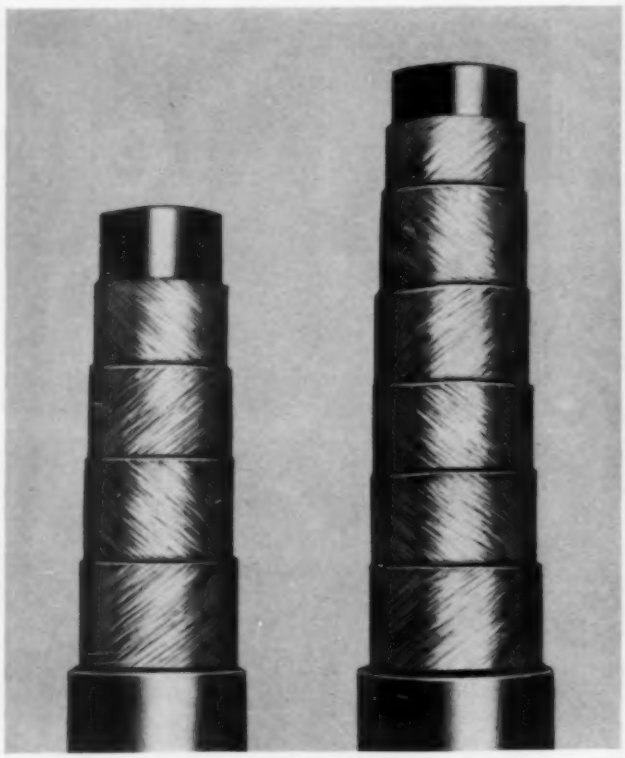

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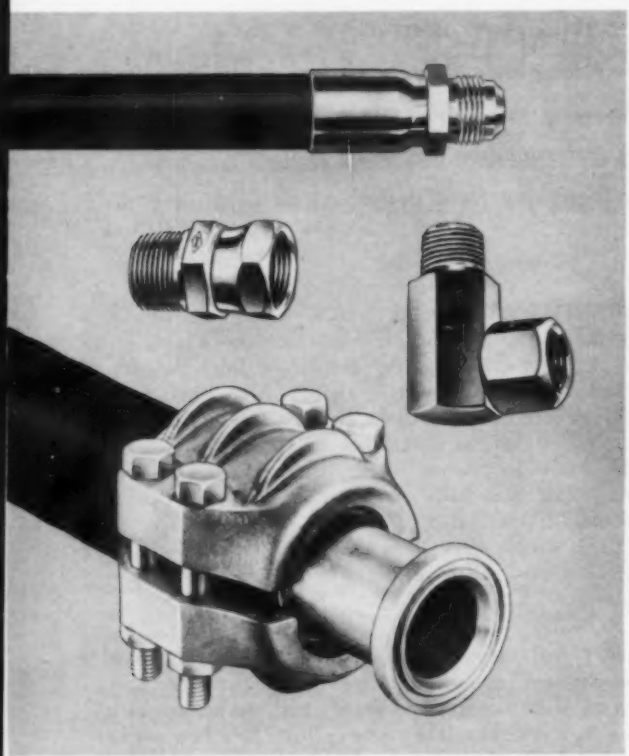

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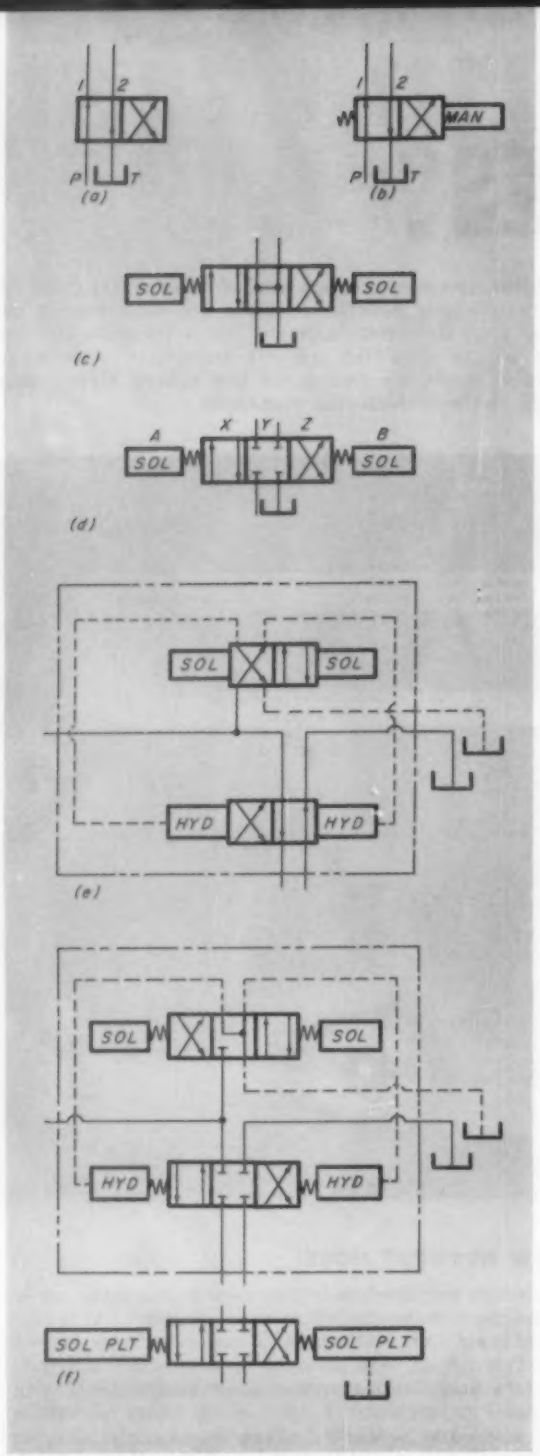


FIG. 1. DEVELOPMENT OF DIRECTIONAL CONTROL VALVE SYMBOLS. Figure 1a represents a simple valve and shows connections, flow paths, and function of the valve. Figure 1b shows a method of actuation of the valve. The other figures represent more complex directional control valves.

How to read

• By **CHARLES F. FRYE,**
President, Auto-Ponents, Inc., Bellwood, Ill.

Many designers are not familiar with the ASA standard graphical symbols for fluid power diagrams even though they were originally published in 1948. Knowing the symbols is a first step in understanding and being proficient in designing fluid power systems.

IDENTIFICATION of hydraulic components with a standard system of graphical symbols was originally formulated by participants in the Joint Industry Conferences (JIC) held in Detroit. Since their first publication in 1948, these symbols have proved so successful that the system has since been adopted by the American Society of Mechanical Engineers, the American Standards Association, and the British Standards Institution.

This article shows how easily you can understand circuits once you have memorized a few basic principles.

A valve consists of a housing with ports for the entry and exit of fluid. Within the housing is a mechanism to stop, restrict, or direct the flow. ASA symbols do not indicate the internal mechanism of a valve, nor its size. They only indicate how flow passes through the valve. An operator flag on the symbol shows how the valve is actuated.

• **Directional Valves**—Simple control of a double-acting cylinder requires four ports in the control valve. Figure 1a shows a simple, directional valve. Line pressure at *P* is directed to a cylinder through port 1, while 2 connects the cylinder to tank in a hydraulic circuit, or to atmosphere in a pneumatic circuit. Imagine the symbol envelope moving to the left. The connections and flow to the cylinder are reversed, and this reverses the piston movement.

Figure 1b represents the same valve operated manually with spring return. Remember that the porting next to the operator flag shows the condition of the valve when it is actuated. External lines are connected to the normal or neutral position of the valve. Thus, in Figure 1b, the neutral position is held by a spring, with flow from *P* to 1. The actuated position is with the valve moved manually to the left, against spring pressure. This is a 2-position, 4-way valve. Two-

circuit diagrams

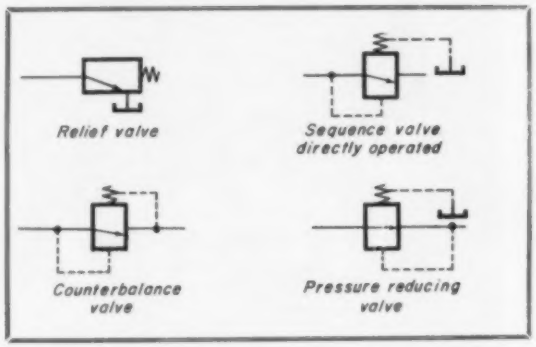


FIG. 2. PRESSURE CONTROL VALVES. The arrow within the envelope indicates flow direction.

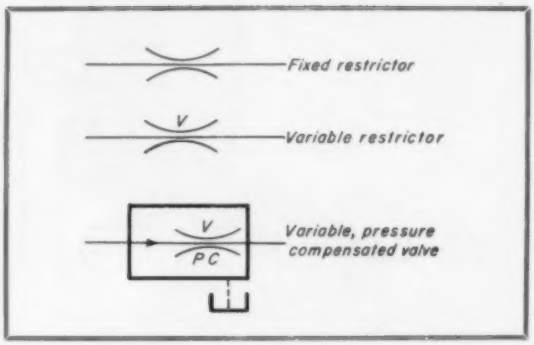


FIG. 3. FLOW CONTROL VALVES. A restriction in the line indicates metered flow.

position, 3-way valves control single-acting cylinders.

More complex circuits often require 3-position, 4-way valves. Two basic types are open center and closed center, represented by the symbols in Figures 1c and 1d. Neutral position of these valves is the center one. Solenoid actuation is shown in the examples. Although the operator symbol infers that the solenoid *pushes* the internal valve mechanism, actually the solenoid usually pulls. This paradox occurs because the symbol must be universal, equally applicable to cam, hydraulic, or pneumatic actuation. These invariably *push* the valve mechanism. In Figure 1d, then, when solenoid *A* is energized, visualize that flow pattern *X* moves right to replace envelope *Y*.

Valves shown in Figures 1c and 1d are spring-centered. When either solenoid is de-energized, the valve returns to center neutral position.

• **Pilot-Operated Valves**—Another important group of valve symbols is the pilot-operated, solenoid-controlled type. A 2-position, 4-way valve is shown in Figure 1e and a 3-position, 4-way in Figure 1f. The simplified symbol is shown below.

These are complex symbols, and for clarity in presentation are enclosed by component enclosure lines. In 3-position valves, pressure fluid is shown directed to the center position. When a solenoid is energized, pilot pressure fluid flows internally to actuate the main control valve. With both solenoids de-energized, the valve is centered by springs.

• **Pressure Control Valves**—Relief, sequence, counterbalance, and pressure reducing valves, Figure 2, are examples of pressure control valves. The arrow within the envelope indicates flow direction and identifies the inlet and outlet ports and lines. If the arrow and outlet line are directly connected in a continuous, straight line, this indicates a normally open valve. With the arrow displaced from the outlet line, this indicates a normally closed valve.

Now consider the offset spring and the pilot or supply pressure lines. They indicate the method of valve actuation. For the relief valve, visualize line pressure compressing the spring as pressure increases. When pressure reaches the valve setting, the arrow moves forward. When it reaches the outlet line the valve opens.

For the normally open pressure-reducing valve, pilot pressure compresses the spring, reducing the flow orifice size and reducing pressure. The pilot line is connected *downstream* from the envelope so the valve can sense the pressure which it is to control. For the sequence and counterbalance valves, pilot pressure acting against spring force *opens* the valve at its pressure setting. Pilot lines are connected upstream.

***ASA symbols are given in the JIC Standards. These standards are included in the* Fluid Power Handbook & Directory *and are also available separately from* Hydraulics & Pneumatics.**

For some pressure control valves the chamber holding the spring section must be drained of oil leaking into it, so that the valve spool can move freely. Sequence and pressure reducing valves have an external drain line because their outlet is not connected to tank. This is shown on the symbol. The outlet line of the counterbalance valve is usually connected to tank, so the drain is internally connected to it and is not indicated in the symbol.

• **Flow Controls**—The basic symbol for a flow control valve represents a restriction in the line, see Figure 3. A *V* in the restriction symbol indicates a variable flow control valve, and *PC* added to the symbol

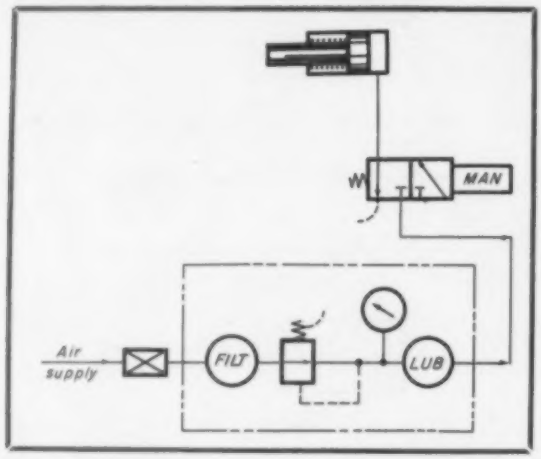


FIG. 4. PNEUMATIC CIRCUIT with a 3-way valve and a single-acting cylinder.

indicates a pressure-compensated valve, which maintains constant flow regardless of variations in pressure.

• **Pump and Other Symbols**—A circle with the appropriate letters inside indicates a pump or other component. *PF* and *PV* indicates a fixed or variable displacement pump. Other common letter combinations are: ACC, accumulator; FLT, filter; HE, heat exchanger; and PS, pressure switch.

• **Direct and Pilot-Operated Circuits**—When reading a circuit, first notice the valves and how they control other components. This is usually easier than following the pressure line from the pump.

Figure 4 shows a pneumatic circuit with the 3-way valve in normal position. The spring of the single—acting cylinder has retracted the piston. When the valve is shifted manually, air is directed to the head end of the cylinder, extending the rod.

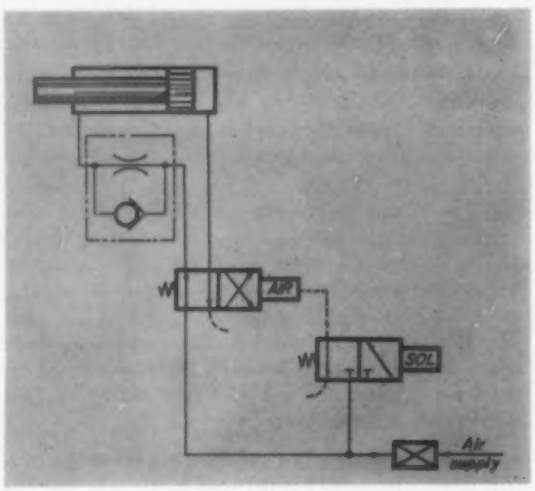


FIG. 5. ROD EXTENSION IS SPEED CONTROLLED by a flow control valve in the exhaust line.

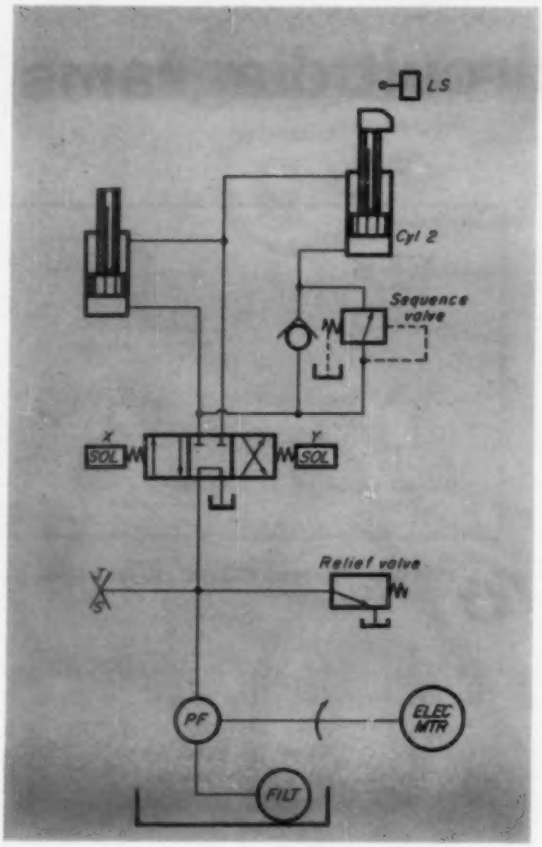


FIG. 6. SEQUENCING CIRCUIT extends cylinder 1 first, then fluid flows to cylinder 2.

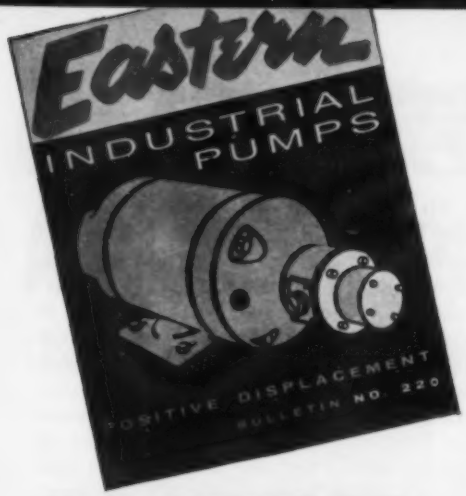
Notice the regulator-filter-lubricator-gage unit in the air line, enclosed by the component line. A manual shut-off valve is connected at the beginning of the circuit.

A solenoid-controlled, pilot-operated air circuit is shown in Figure 5. Everything is in neutral: the solenoid is de-energized and the cylinder is retracted. When the 3-way pilot valve is energized, air flows through it and shifts the main, 4-way control valve, directing air to extend the cylinder. Rod extension speed is controlled by the restrictor valve which meters-out air flow in the exhaust line. When the solenoid is de-energized, the reverse stroke starts, because both valves are spring offset. The piston rod returns fast because air by-passes the restriction through the check valve.

• **Sequencing Circuit**—A simple, hydraulic sequencing circuit appears in Figure 6, with a fixed displacement pump, tank filter, relief valve, and pressure test point. The valve is in neutral position, and initial movement is toward the right. Thus when solenoid *X* is energized, oil flows to extend cylinder 1. When the cylinder reaches the end of its stroke, pressure builds up in the line and opens the sequence valve. Fluid then flows to extend cylinder 2. At the end of its stroke, the rod trips a limit switch which reverses the solenoid

Continued on page 94

Circle 44



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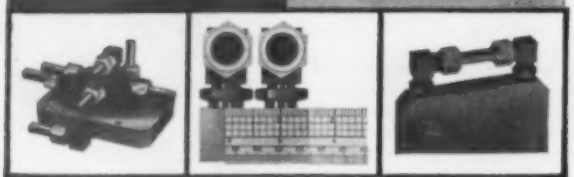

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HOW TO READ CIRCUIT DIAGRAMS

controlled valve, and both cylinders retract rapidly. Fluid by-passes the sequence valve through the check.

• **Hi-Lo, Meter-Out Circuit**—Figure 7 shows a pilot-operated valve controlling a cylinder from a hi-lo pump circuit. This is a pump arrangement to limit power requirements.

When solenoid *A* is energized, pilot-operator *X* is actuated and flow is to the cylinder head end. At first exhaust fluid flows freely through the deceleration valve. After the cam closes the deceleration valve, piston speed is reduced because fluid must exhaust through the flow control valve. This is a meter-out circuit, so there is back pressure in the exhaust line. The return stroke starts when solenoid *B* is energized. This actuates operator *Y*. Cylinder return is rapid for the full length of the stroke. Flow moves first through the check valve and then also through the deceleration valve after its spring opens it.

The hi-lo pump feature saves power. The remotely operated unloading valve remains closed while pressure is below 500 psi, during return and the first part of extension. Delivery from both pumps produces rapid cylinder motion. After the deceleration valve closes, pressure increases in the cylinder inlet line, the unloading valve opens, and the 15-gpm pump unloads to tank. The 3-gpm pump then continues to supply fluid for slow piston movement. ▼▼▼

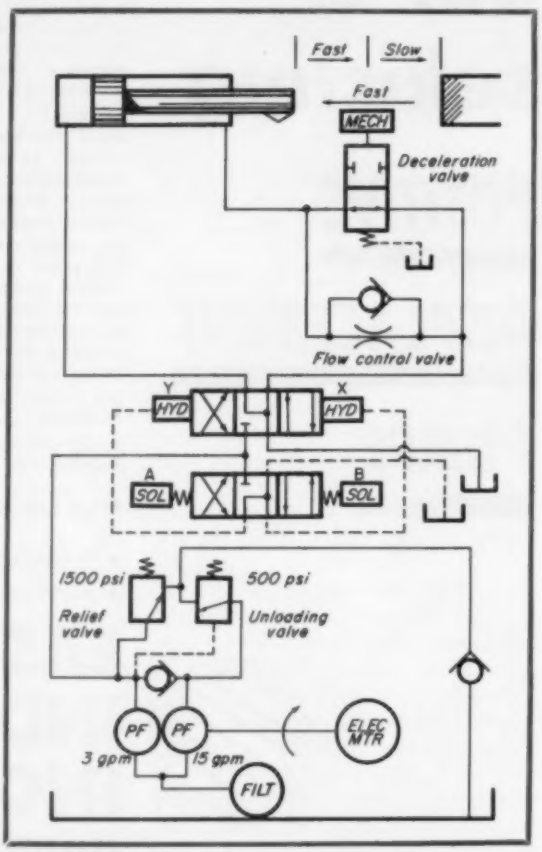

FIG. 7. HI-LO CIRCUIT is a pump arrangement to limit power requirements.

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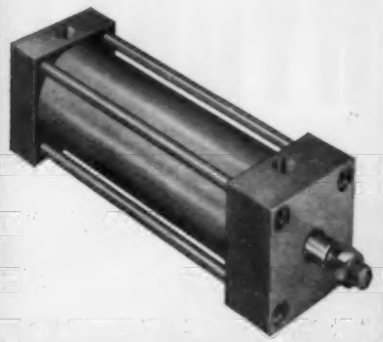

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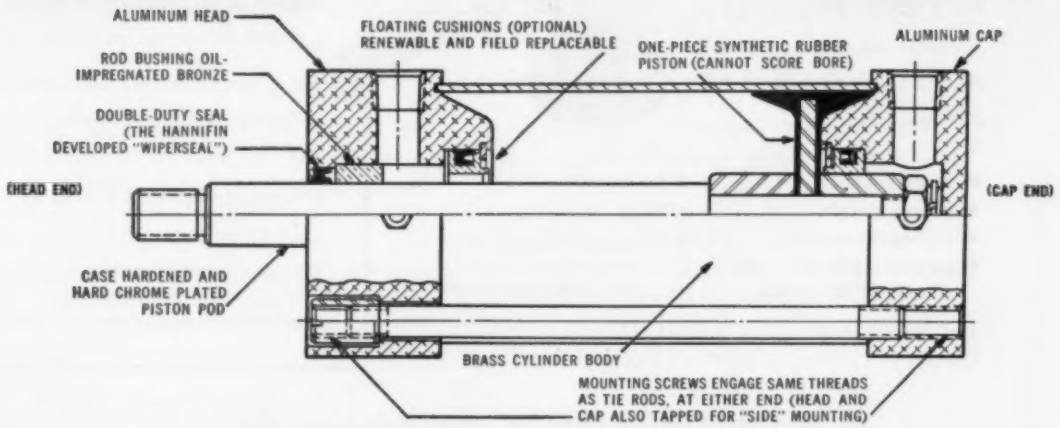
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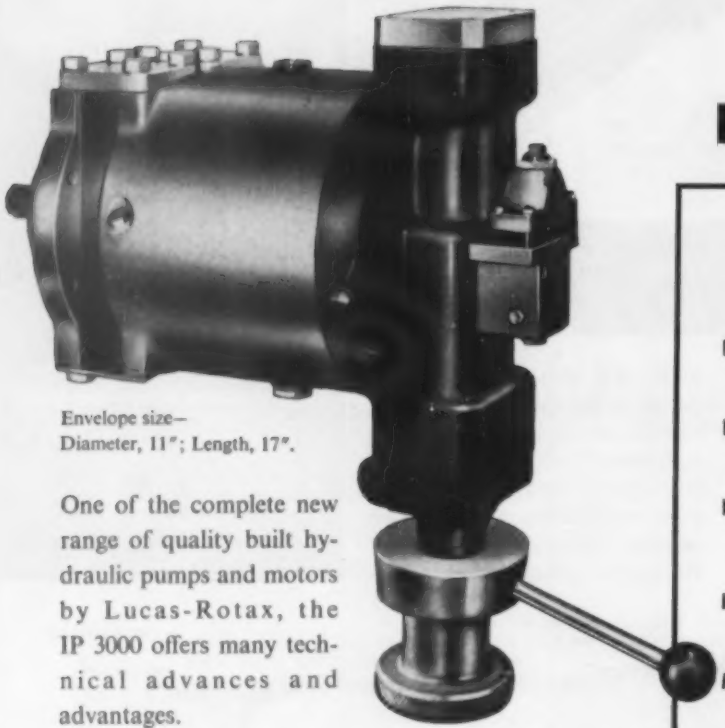

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Nominal working pressure (peak)	5000
(lb. per sq. in) (continuous)	3000
Nominal speed (peak)	2000
(r.p.m.) (continuous)	1800
Input h.p. at 1,000 r.p.m. and 1,000 lb. per sq. in. differential	38
Max. Torque (lb./ft.) per 1,000 lb. per sq. in. fluid pressure differential	200
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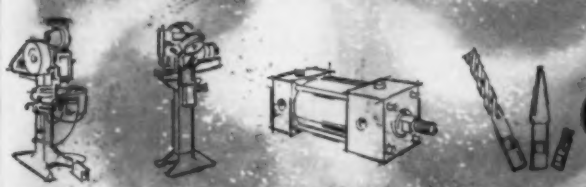

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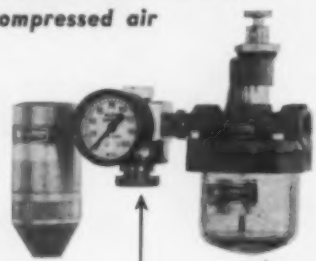

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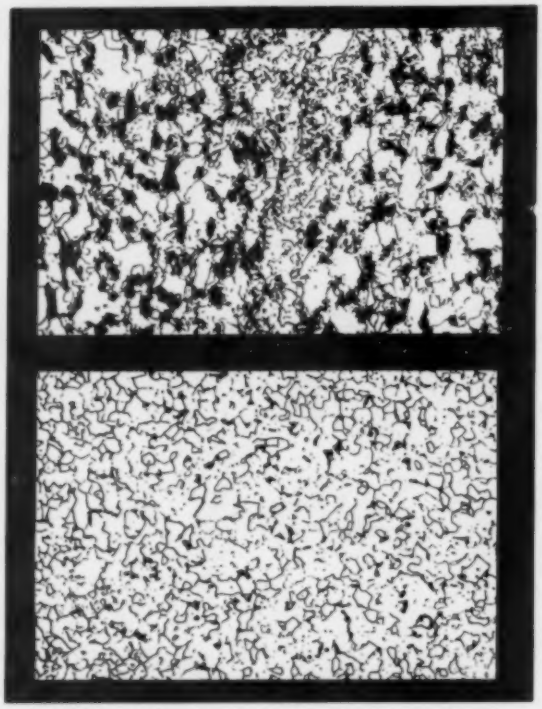
Continued from page 71



PHOTOMICROGRAPHS of weld area show tubing after welding (top) and after normalizing (bottom). Notice homogeneous appearance of metal grains. Magnified 100 x.

tudinally 90 degrees on each side of the weld and the sample opened and flattened. There shall be no evidence of cracks or lack of penetration or overlaps resulting from flash removal.

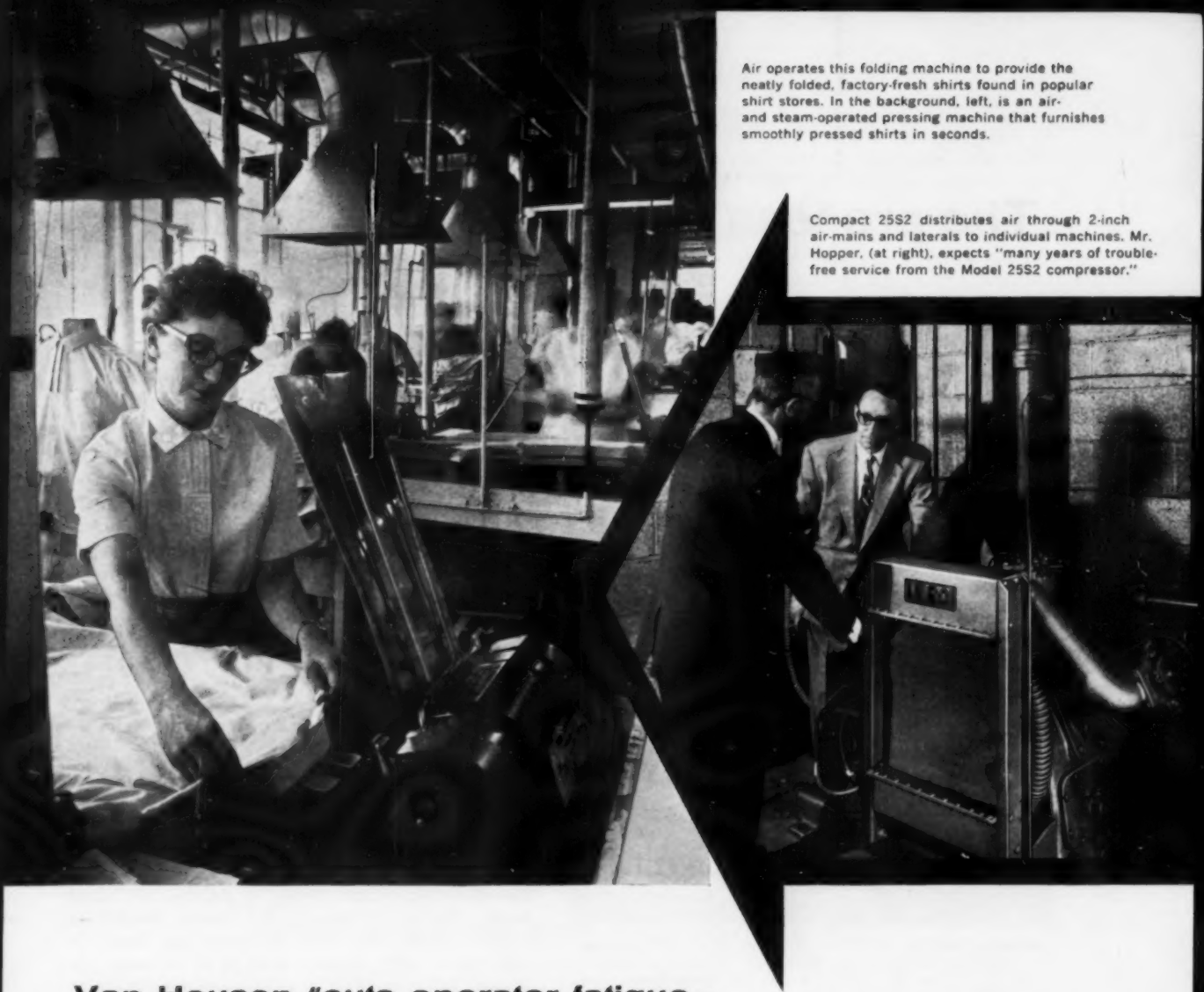
LINE TUBING TOLERANCES

NOMINAL SIZE-In.	OD-In.	ID-In.
⅜	±.002	±.005
Over ⅜ to ⅝ Inclusive	±.0025	±.0025
Over ⅝ to 2 Inclusive	±.003	±.003
Over 2 to 2½ Inclusive	±.004	±.004

- **Expansion Test**—A suitable specimen shall be taken from each 1500 feet or less of tubing and subjected to an expansion over a plug. The outside diameter must be expanded 25% throughout a length equal to the outside diameter of the tubing or one inch, whichever is greater. There shall be no evidence of cracking in this test.

- **Pressure or Electrical Test**—Tubing supplied under this specification shall have been hydrostatically tested at a fiber stress of 20,000 psi or at an actual pressure of 5000 psi, whichever is less, based on the applicable minimum wall, or tested by use of a non-destructive electrical test approved by the purchaser. ▼▼▼

Circle **90** →



Air operates this folding machine to provide the neatly folded, factory-fresh shirts found in popular shirt stores. In the background, left, is an air- and steam-operated pressing machine that furnishes smoothly pressed shirts in seconds.

Compact 25S2 distributes air through 2-inch air-mains and laterals to individual machines. Mr. Hopper, (at right), expects "many years of trouble-free service from the Model 25S2 compressor."

Van Heusen "cuts operator fatigue– ups output per machine by 10% to 20%" with a

LE ROI 25-HP STATIONARY COMPRESSOR

Shirt-making is exacting work. It's so tiring that an operator's output can drop 40% in five hours. To reduce fatigue and to maintain efficiency, "we prefer air control for the more delicate operations of sewing and trimming machines, laundry, pressing and creasing work," reports Charles G. Hopper, assistant to the production manager of the Pottsville (Pa.) plant of Phillips-Van Heusen Corp.

At least some of the credit for reducing fatigue and increasing production is given to the 25 horsepower Le Roi compressor which provides air-power in their shirt factory.

The 105 cfm, 125 psi capacity of the Le Roi 25S2 air-cooled compressor more than meets current needs, and provides for the addition of more air-operated machines. Mr. Hopper states that the unit operates 10 hours a day, five and one-half days a week. To assure dependable air supply, valves of the 25S2 are inspected weekly, and oil is changed every 200 hours.

Why don't you check the benefits of pneumatic operation? Le Roi can meet your needs with Westinghouse unit-type and Le Roi stationary air compressors from ½ to 100 hp. See your Le Roi distributor for more information. Or write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

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SPECIAL REPORT

The process industries-new applications

DETROIT—Fluid power applications in the process industries were emphasized at the recent hydraulic conference sponsored by Vickers, Inc. Prepared papers discussed hydraulic systems on a bread making machine, paper lamination equipment, and the manufacturing processes of a large chemical company. Additional papers discussed design of a numerically controlled, punch press and the use of hydraulics on a blow molding machine.

General discussion focused on component requirements and new product developments.

MODERATORS for the 2-day conference were Uel P. Jennings (l.) Development Supervisor, Mechanical Development Laboratory, E. I. duPont de Nemours & Co., and David Sloane, Vice President, Lester Engineering Co.

• **Fluid Motor Potential**—Fluid motors with their higher efficiencies and higher operating pressures do many jobs which are impractical with an electric motor. This was the expression of Orville Johnson, development engineer at DuPont, who went on to explain in his prepared paper that fluid motors respond almost instantly to changes in oil flow, and are easily controlled with respect to force, speed, and direction. He pointed out that fluid motor drives have been the answer to many problems in mechanization at DuPont, especially where the driving motor must be installed in an explosive atmosphere. The pumping unit can then be located at a safe distance.

Emphasizing the difference in space required by fluid motors and electric motors, he also recognized that space saved with fluid motors is taken up by the pumping unit. But this requires only floor space, he said, and the pumping unit can usually be placed where it will not interfere with the operating machine.

Fluid motors should be considered for applications having long strokes at high speed. Driving through either a rack-and-pinion or chain-and-sprocket arrangement, a fluid motor can produce very long strokes.

In the 500 to 800-psi range used at DuPont, cylinder ports are usually too small for stroke speeds over 20 inches per second. In applications of high speed reciprocation, the fluid motor serves very well, he said, pointing out that the applications are on light machinery with small moving mass.

• **Food Processing**—Describing his company's tape controlled, bread making equipment, Maynard Euverard of Union Machinery Div., American Machine & Foundry cited these reasons for a hydraulic drive:

- Requirement for speed control within 1% from half speed to full speed.
- Extensive use of water for washing down equipment. This requires keeping electric drive units out of the food handling area.
- Compactness of fluid motors.
- High efficiency of energy transfer.
- Reliability under a pulsating load of 250 to 450 cycles per minute. Euverard indicated that leakage which would be especially troublesome in food processing is not a problem at the 1500 to 2000-psi range of his equipment. The system uses compression type fittings.

• **Paper Laminating**—Ray Spencer, Vickers, showed how hydraulics meets requirements of paper laminating equipment producing material for cereal boxes. The servovalve-controlled system installed at General Foods takes half the space that would be required by a d-c electrical drive to do the same job. It costs less than either a servo pump installation or an electrical system. A careful maintenance analysis in the planning stage showed advantages for a hydraulic system. Web speed is 800 ft/min.

• **Pilot Relief Valve Popularity**—A large majority of the conference attendants indicated that they are using pilot relief valves. Some are using these for dual pressure operation; most are using them for unloading pump delivery at low pressure when not needed. Vickers' Ron Render said that a new design with integral, solenoid-operated, 2-way valve is in development.

• **Longer Solenoid Life**—Ten million cycles, compared to the former one to two million cycles is the capability of new air-cooled solenoids which have been made stronger and have been designed for better heat transfer. In discussing solenoid failures, Vickers' Don Sweeney named the two main causes: excess heat, and mechanical failure. Voltage which is too low to pull in the solenoid plunger accelerates heating, he said. Voltage which is more than 10% over rated contributes to mechanical shock and breakage.

The new solenoid cover is ribbed to hold the solenoid in place, and for good heat transfer with reduced

for hydraulics

air space. This arrangement makes it impossible to assemble the solenoid without the cover. Rubber pads in the solenoid give a buffer action which protects against mechanical failure.

• **Higher Valve Backpressure**—By interlocking the solenoid push pins to the spool of their ⅛-in., solenoid-operated valve, Vickers has increased permissible back pressure from 50 psi to 1000 psi, making the valve suitable for tandem operation. With loose push pins, back pressure opposed solenoid thrust. Together with an increase in spool diameter, this change allows the valve to pass 8 gpm with 55-psi drop, compared with a former rating of 1½ gpm. The valve can now pass 12 gpm without malfunction.

• **Valve Sticking**—When valves remain energized and under pressure for long periods without passing flow, a small leakage flow past the spool lands causes *silting*. This is a building up of contamination particles which form a "log jam" in the spool-sleeve clearance of only a few 10-thousandths of an inch. When the valve is de-energized, the 10 to 11-lb spring force is not enough to break this silting, and the valve sticks. Suggestions to solve the problem were: keep the oil clean, design a spool without annular grooves which can trap particles, design the system for periodic valve operation to clear it of silting.

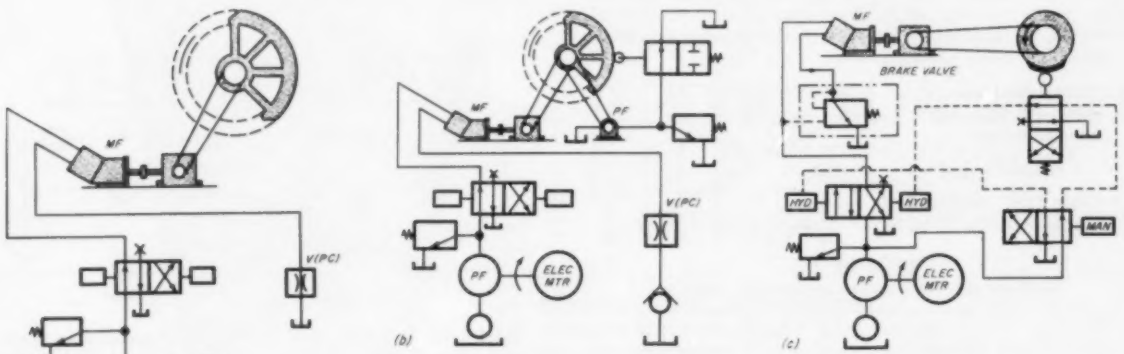
• **Plug-in Solenoid—Pro and Con**—Opinions are divided on the value of plug-in solenoids to simplify maintenance. Forrest House of Bendix Products Div. pointed out that an electrician is not needed to change plug-in solenoids, and this is a time saver when equipment is down. But Al Schaljo of Ford Motor in Windsor pointed out troubles he has had with insulation rubber and pin design in air valves. He said that the plug-in wiring should be designed so that it can be bypassed if necessary. Bernard Kunka of Acme Steel stressed the need for terminal blocks to make connections. He is now splicing in a connection box.

• **Tell-Tale Valve**—There's a need for an indicator which shows whether a pilot-operated valve has shifted. Robert Oldfield of Corning Glass Works was among those who indicated such a device would be helpful. He has worked out a design using a pin at 90-degrees to the valve spool. The pin can be inserted to feel whether the valve has shifted. However, this feature on commercial production valves is not in the picture because of the extra cost and probable maintenance of the device itself.

• **Air Controls**—Air-controlled, hydraulic valves are needed in the glass industry and other continuous process applications. Fred Dahlman of Corning Glass and William Stutske of Kimble Glass both indicated the

Continued on page 102

INERTIA DAMPENING WITH FLUID MOTOR DRIVES



INERTIA DAMPENING IS REQUIRED in a machine which can overdrive the power source during part of the cycle. In (a), speed of the unbalanced load is maintained by a flow control valve connected to meter fluid out of the fluid motor. Pressure compensation feature of the flow control valve keeps flow constant regardless of pressure variations. The circuit in (b) is for a machine with several gears in the power transmission to an indexing device. Backlash required a brake on the index. In the condition shown, the motor is under load and the cam valve is unloading the braking pump which is driven off the load. As the load rotates and becomes negative, the cam valve closes, so that oil from the load-driven pump must pass through the relief valve. This takes energy from the load and brakes it. Circuit (c) shows application of a brake valve installed in a drum-drive system. The valve is either held open by motor inlet pressure or creates a back pressure on the motor when pump delivery is shut off. The cam valve in the pilot circuit stops the drum in the same position each time.

From "Fluid Motor Applications & Circuit Tips" by O. H. Johnson.

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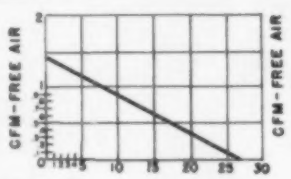

MODEL LC

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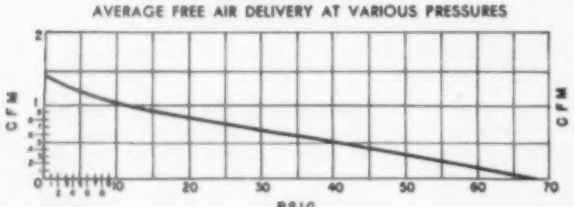

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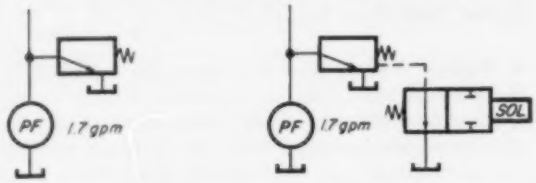
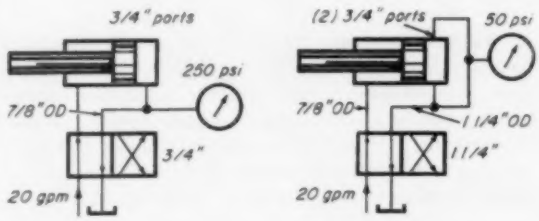
need for air-operated valves. Dahlman said that air operation is more reliable than electrical especially in high temperature areas. Stutske said air control allows the hydraulic system to be timed from other air-operated equipment. He also mentioned that maintenance men are more familiar with air systems than electrical circuits. Air valves are especially good in exposive atmospheres, DuPont's Orville Johnson said.

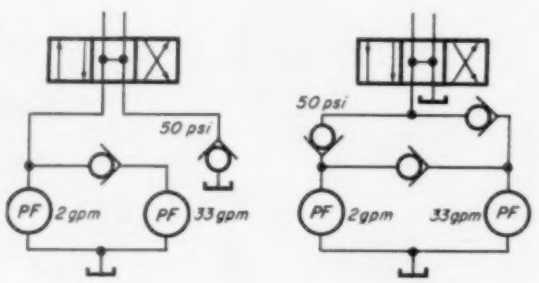
CIRCUITS TO KEEP OIL COOL



Using a vented relief valve (right) drops pump pressure to 30 psi when flow is not required, rather than discharging at 1000 psi (left).



Retracting cylinder with 2:1 piston creates 250 psi as 40 gpm flows through ¾" ports. Using a larger valve and cylinder with 1¼" head-end port or two ¾" ports, and 1¼" OD tubing drops backpressure to 50 psi.



Check valve with 50-psi spring creates pilot pressure—and also heat—when 35 gpm discharges through it (left). Using only 2-gpm pump for pilot flow lets 33 gpm pump unload to tank (right).

By Warren Brown, Vickers Inc.

• **Valve Shifting Time**—Should it be included in manufacturers' specifications? Although it is useful in some design situations, the opinion was that it would be hard to include along with other ratings in catalogs. Shifting time is affected by other variables such as

Continued on page 104

Expensive, time-consuming machining operations can often be reduced or eliminated by use of Republic ELECTRUNITE Special Smooth I. D. Hydraulic Cylinder Tubing.

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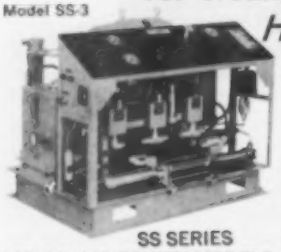

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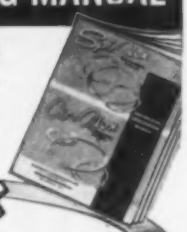

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pilot pressure, voltage, differential pressure across the spool, manufacturing tolerance, and oil temperature and characteristics. Furthermore, other factors which must be considered when shifting time is critical are shifting time of electrical control and flow acceleration as the valve ports open.

• **Straight Thread Progress**—Designers acknowledge advantages of straight thread plumbing connections, but for industrial production machine applications, they have been almost forgotten. Although pumps are available with straight thread ports at no extra charge, a very small number are being sold. The standardization problem is the big barrier, and Robert Farrar of General Motors underscored it by telling about his efforts to switch over to straight threads. Gauges are one obstacle in standardizing on straight threads.

Pioneering the movement, though, is Ford's Windsor plant where Al Schaljo indicated that specifications now make straight threads a must. Convert 80% of your joints to straight threads and eliminate 60% of your leakage, he said.

• **Flow Control Accuracy**—A recent feature which has improved accuracy is temperature compensation for flow control valves. In contrast to sharp edged orifices which do not account for other restrictions through the valve, temperature compensation makes the metering orifice smaller as the oil heats up.

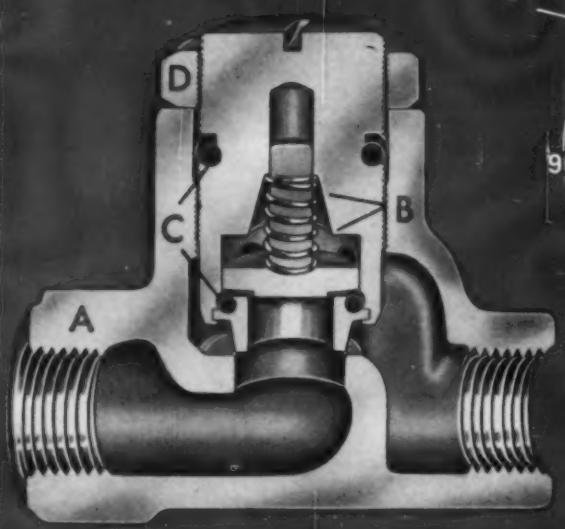
In answer to a question on the use of a flow control valve for a variable speed timing drive, Don Sweeney of Vickers gave test figures showing variation as flow was turned off and on. At 500 psi and 125 F, flow varied less than 1 cu. in./min. at nominal settings from 10 to 500 cu. in./min.

• **Pump Development**—New vane pumps have been designed by Vickers for high peak pressures, maximum speeds, good fill characteristics, and simple maintenance. Although originally pointed at mobile applications, it was indicated that industrial applications have been very satisfactory. At United Shoe Machinery a pump was subjected to 3000 pressure cycles at 65 cycles per minute, ranging from zero to 2500 psi. Other than some wear near the suction quadrant of the ring, the pump was in excellent condition. At Chrysler where there had been trouble with emulsion type, fire-resistant fluid, one of the new pumps was in good condition after 1500 hours, of which about 30% was at full pressure of 600 psi. There was some wear in the suction quadrant, but the vanes were within engineering specifications, and rotor surfaces were in excellent condition.

A later pump development has been a vane type for 1800 rpm, 2000 psi, using a new vane design. This is suitable for applications where a 2-stage pump was used before.

• **Pumps for FRF**—Higher specific gravities of fire-resistant fluids produce pump suction problems, and speeds must often be reduced. Specific gravities over 1.3 have given troubles. Some phosphate ester fluids have a specific gravity of 1.46. New pump designs are being developed to meet these needs. ▼▼▼

THERE'S A QUALITY DIFFERENCE IN AIR CONTROL COMPONENTS...



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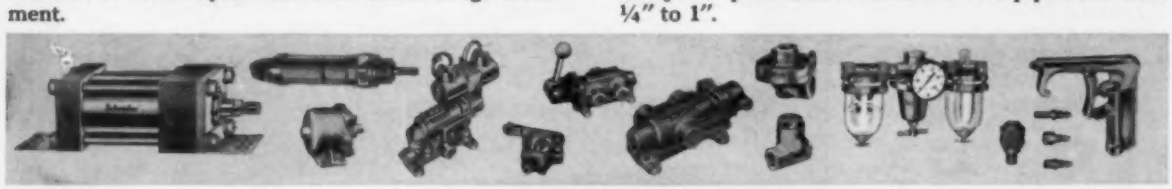

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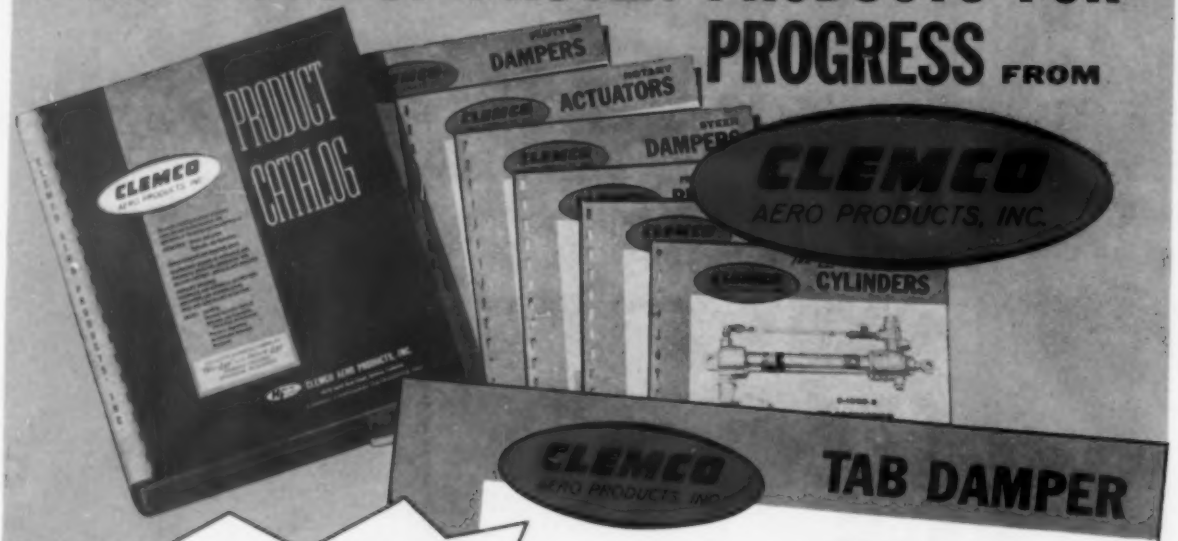

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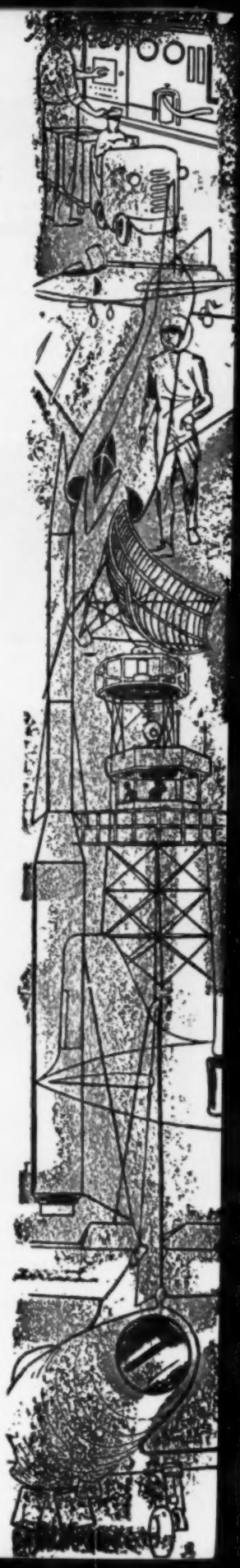
AEROSPACE SECTION

Fluid Systems For Flight and Ground Support



General Dynamics Reorganizes Convair

General Dynamics Corp. recently created five new operating divisions. All are former units of Convair. The new divisions are: Astronautics, Fort Worth, Pomona, San Diego, and Daingerfield. The former Convair General Office at San Diego will be eliminated. Key personnel will be assigned to the corporate staff or to operating divisions. The changes will provide a higher degree of managerial control and also give greater flexibility to those individual divisions serving different markets and technologies.

Parker Aircraft to Sell Boeing Tube Fittings

A high pressure tube fitting developed by Boeing Transport Division, Renton, Washington, will be manufactured and sold by Parker Aircraft Corp., Los Angeles, a division of Parker-Hannifin Corp. The fitting has shown greater reliability than conventional joining systems in initial tests and is at least 50% lighter. It is a mechanically swaged joint, having three parts. Parker will produce two types, a permanent and a removable model.

Bendix Hamilton Engineering Moving to South Bend

Engineering facilities of Bendix Hamilton Division are being combined with those of the Bendix Products Division, South Bend, Ind. This move will aid development of new designs and product evaluation through access to the outstanding environmental and material laboratories, computer facilities, prototype manufacturing, and other engineering support services of the Bendix Products Division.

Greer Wins Contract for Titan II Blast Valves

Two prime contracts have been awarded by the Corps of Engineers to Greer Hydraulics, Inc., for the engineering, production, and field servicing of hydraulic power and control systems for Titan II blast valves. These systems provide for normal and emergency actuation of control valves in the Titan II vent system. These initial contracts, totaling about a quarter of a million dollars, mark the first time that sophisticated circuit design, based on block manifolding of hydraulic systems, will be used for missile silo installations.

For more news about fluid systems see page 117

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The U. S. Air Force tilt wing X-18 operates VTOL (vertical take-off and landing), STOL (short take-off and landing), or conventionally. Its flight control surfaces are convertible during flight. Other control methods were considered before deciding on an all-hydraulic system. Electric controls, for example, had some desirable aspects, but would have required more power than could be taken from the engines. Fluid power met the prime requirements of reliability and safety, and also appeared to minimize the experimental problems that would be encountered.

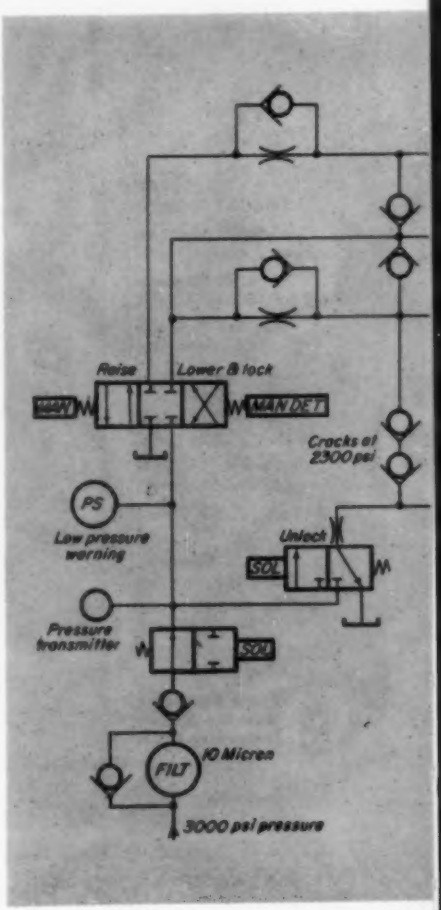


FIG. 1. THREE DIFFERENT WING POSITIONS (VTOL, STOL, and conventional) are demonstrated by the X-18 in ground tests. Several hydraulic sub-systems, part of the airframe structure, and the power plants were adapted from existing applications.

Self-locking cylinders tilt wings

• By **STANLEY O. NELSON,** *Mechanical Group Engineer, Hiller Aircraft Corp., Palo Alto, Calif.*

HOW to power the X-18's wing tilting motion was a major consideration in the plane's development. Returning the wing from vertical to horizontal position had to be rapid and positive. Hydraulic cylinders offered precise, powerful, fast action.

In preliminary studies, we considered using an explosive gas generator boost for quick lowering of the wing. However, the cost would have been prohibitive. Also, at one stage a high-pressure accumulator was considered to assure rapid tilt action. In final engineering, however, the accumulator (300 lb weight penalty) was discarded for two 27-gpm hydraulic pumps that fully lower and lock the wing in 7.5 sec. Raising the wing requires about 18.5 sec.

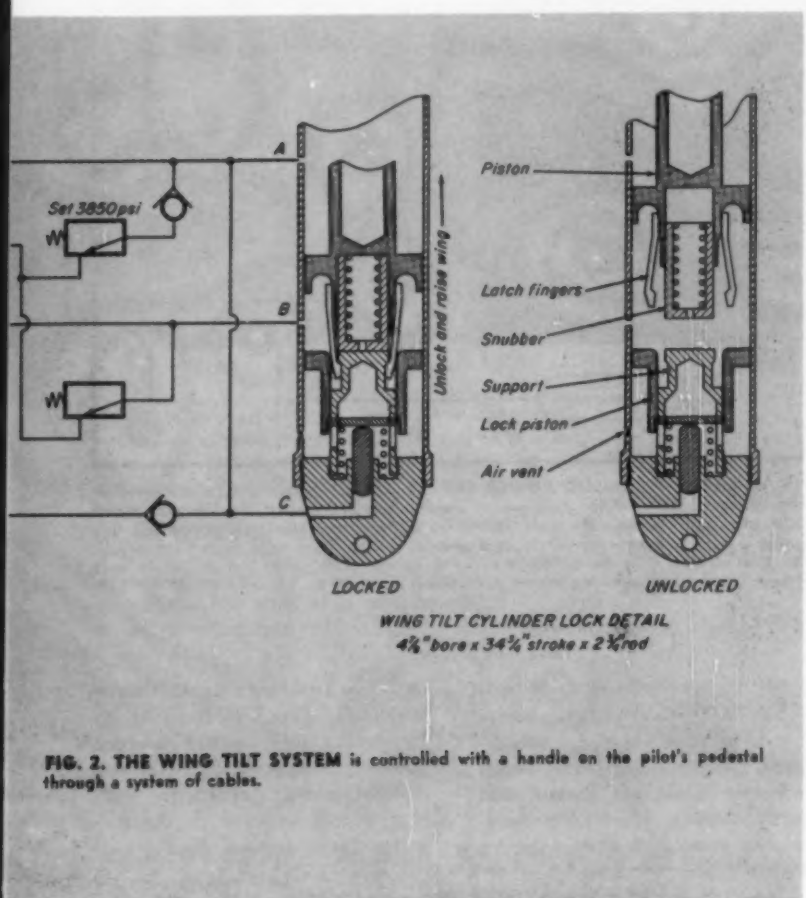


FIG. 2. THE WING TILT SYSTEM is controlled with a handle on the pilot's pedestal through a system of cables.

• Hydraulics Unlocks Wing Tilt Cylinders—Each wing tilt cylinder has a hydraulically operated downlock. (See Figure 2.) Pressurizing Port *B* raises the wing from its conventional, horizontal position. The pressure drives the lock piston down, and the spring steel latch fingers spring free of the support. Continued pressure at *B*, extends the piston rod and raises the wing. Pressurizing ports *A* and *C* lowers the wing from a vertical position. Pressure at *A* retracts the piston rod, lowering the wing, and pressure at *C* drives the lock piston up. Continued pressure at *A* and *C*, locks the wing. The snubber on the retracting piston hits the fixed support, cushioning the wing movement. The latch fingers push down the lock piston until the fingers engage the support. The plunger at *C* can then push up the lock piston around the fingers, locking the piston and wing.

There are two wing tilt cylinders, one on each side. Each is connected separately to one of the two 3000-psi systems. In an emergency, one cylinder could actuate wing tilt. Either the right or left hydraulic system can operate the tilt cylinders. Valving allows one cylinder to move freely if its system become inoperative.

Speed of each wing tilt cylinder is controlled by a metering valve operated remotely through a cable system from the pilot's pedestal. A single control handle operates each system's control valve through its own cable system, but valve stems are connected together for coordination. Speed of wing-tilting is proportional to control

handle movement. When the handle is in neutral, the wing is hydraulically locked in any position. The speed control valve is spring-centered and detented to neutral. A lock detent holds the handle in *high-speed-down* position.

• **Orifice Restricts Wing Cylinders**—One-way, flow-restricting orifices restrict wing raising speed, but not the lowering speed.

To isolate the system for testing, a 2-way valve allows the pilot to check each system individually.

A check valve protects the 10-micron filter from peak pressures and prevents backwashing through the filter in case of reverse flow.

The two check valves downstream from the relief valve act like a regenerative circuit to keep the cylinder from "starving." Oil in the system is immediately available for a chamber of the wing tilt cylinder having low pressure due to a negative load. The oil does not have to pass through the pump first.

• **Wing Unlatch System**—A sub-system holds the wing down while unlatching the wing tilt cylinders. A pressure of 3000 psi is applied to the upper end of the system at Port *A* to remove the latching preload. Simultaneously, 700 psi is applied to port *B*. This moves the lock piston down and frees the latching fingers. This is done to insure that both cylinders are unlatched before raising the wing. The pilot verifies this by a DOWN & LOCK indicator on the instrument panel. Check valves and a small orifice are in the system to eliminate the sub-system effects on wing tilting.

• **Two Independent Hydraulic Systems**—The X-18 hydraulic circuitry is distinctive because it has two, independent, 3000-psi systems, right and left. Fluid does not intermix between the two systems. There is no cross-manifolding. If one system should fail, the other can support critical functions. All operations are dualized.

The X-18's design philosophy was to provide simple, uncomplicated, functional systems which fail safe. Elaborate control and safety devices which are themselves a potential source of danger have not been included.

FIG. 3. HILLER X-18 IN FLIGHT with its wings tilted at 20 degrees. Maximum wing tilt angle so far achieved in flight is 50 degrees. The long, external tailpipe carries thrust which is controlled by the tail jet divertor cylinder.

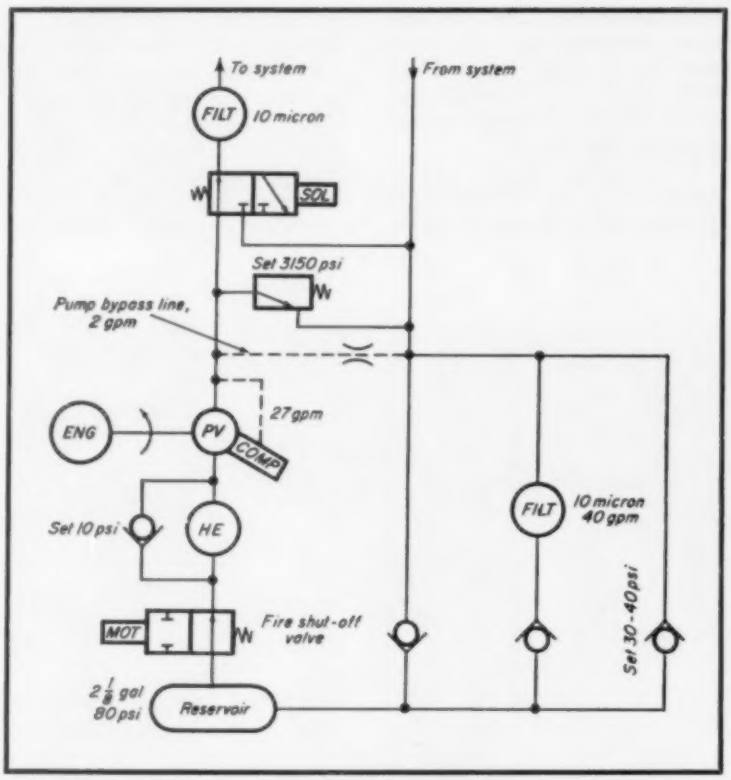
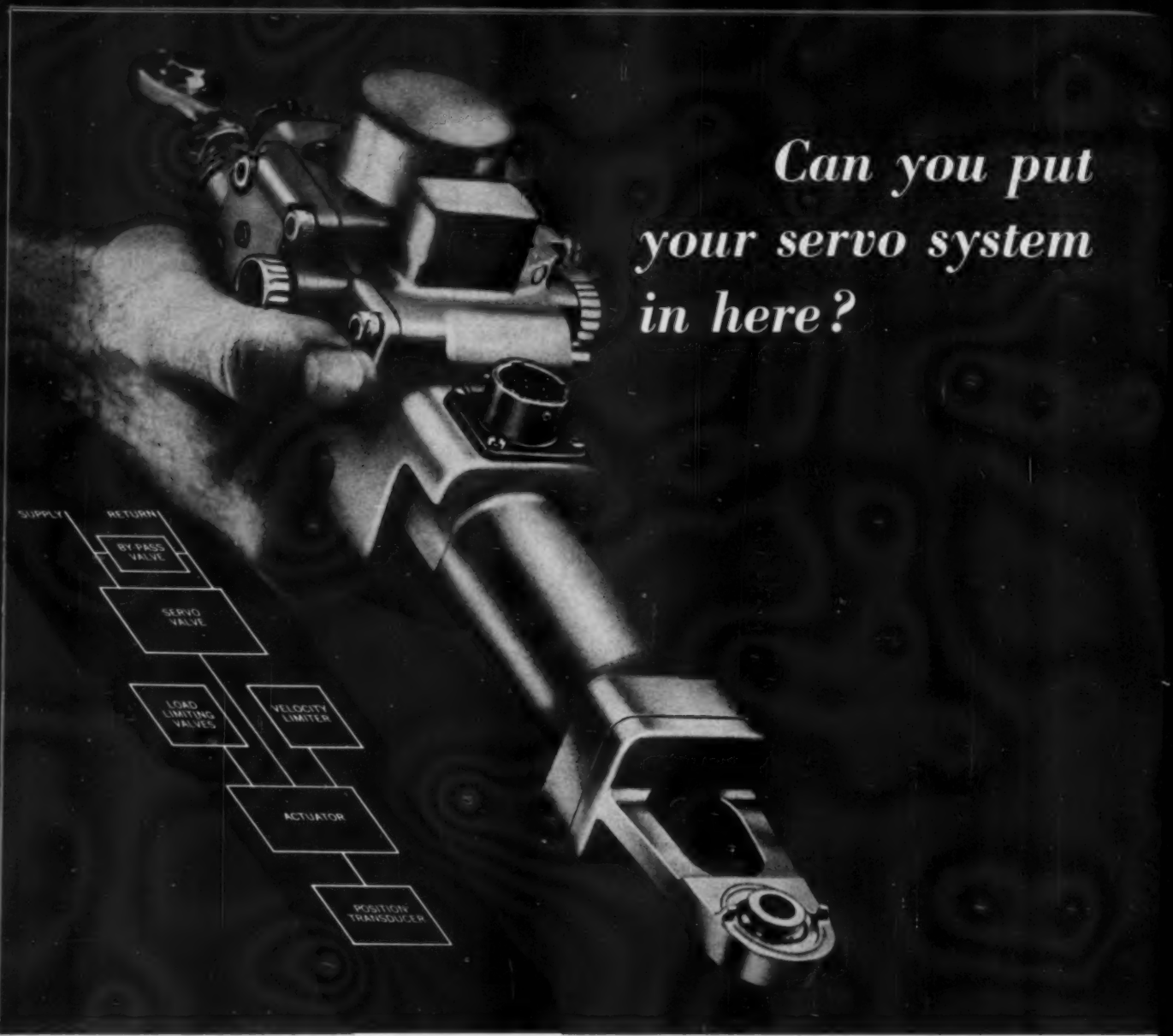


FIG. 4. EACH HYDRAULIC POWER SUPPLY SYSTEM has a pressurized reservoir to pressurize the inlet of the main pump. The reservoir can by-pass the idle main pump for testing and bleeding the main system at low pressure. Maximum pressurized flow during a fast rate of wing tilt is 25.5 gpm or 55 hp from each system's hydraulic pump, or 110 hp from both. This is about 2 hp for each gallon per minute in each system. Power required during normal operation is about 40 hp.

• **Two Independent Power Systems**—The X-18 has two, independent fluid power sources. Each is supplied by a variable volume pump driven by each engine and mounted on the propeller transmissions. Each power

Continued on page 112



This is a packaged servo actuator designed by Hydraulic Research for missile flight control. It is a completely integrated system with these advantages:

- increased reliability
- less contamination vulnerability
- lower production costs
- single vendor responsibility
- reduced weight
- improved compatibility of components
- simplified test and checkout

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system is completely independent of the other, and has its own fluid reservoir, lines, and system controls. Since fluid does not intermix (not even in an emergency) between the two systems, contamination or leaks in one cannot cause a failure in both systems.

Because of the high speed (4010 rpm) at which the main pumps operate, each system has a pressurized reservoir to pressurize the main pump's inlet and prevent cavitation. The pressurized reservoir has other functions. It primes the main pump when starting the engine. It pressurizes the high pressure system, so that the system may be tested for operation and leaks and may be bled easily—at low boost pressure. A high pressure air bottle pressurizes the reservoir.

The reservoir is pressure relieved to atmosphere. It supplies fluid during any aircraft attitude from horizontal to vertical. It supplies fluid continuously during negative *g* maneuvers. Enough fluid is stored in the reservoir to actuate the wing tilt mechanism through half a cycle with a return line broken.

The return line filter (which is also used on the Boeing 707) is a special design. It is rated at 40 gpm and has a by-pass relief valve set at 30-40 psi. Maximum return flows are higher than pressure line flows because during wing lowering, the wing-tilt cylinders return flow from their head ends. Cylinder outlet flow is 22½ gpm and inlet flow is 15 gpm, a difference of 7½ gpm. Thus, maximum system return flow during flight is (7.5 plus 25.5) 33 gpm. Check valves prevent backwashing contaminants out of the filter into the rest of the system during reverse flow.

As with wing tilt, aerodynamic, flight control surfaces are 100% hydraulically operated. An ingenious cable mixing control interrelates engine power and airplane attitude controls during hovering and transition to forward flight. Simple controls for precise mixing of flight controls are essential because guidance shifts from one flight control surface to another. Yaw control shifts from the airplane rudder in level flight to the ailerons during hovering and transition movement. Roll control shifts from the ailerons to varying power-output of the right or left engine. And pitch control shifts from the elevators to the tail jet diverter.

One hydraulic cylinder with integral servovalves moves each of the four ailerons. An aileron control cable operates each servovalve. As the aileron responds, a position feedback nulls the input. A manual override moves the aileron if the cylinder fails. No speed limits are in the system, since it is limited by the manual input control which it follows closely. The aileron cylinders are tandem, double-acting. Each is actually two in-line cylinders on one shaft.

A filter in the inlet line to each cylinder has a 10-micron, stainless steel mesh element. Bypass relief valves in the filter were eliminated to prevent bypassing contaminants into the servovalve. The stainless steel element is necessary to withstand the possible high differential pressure (3500 psi) across the filter.

A 3-way valve permits checking each system. In its normal position, pressure is open to the cylinder and return port is blocked. When the valve is energized, the pressure port is blocked, and the cylinder ports are interconnected to allow fluid movement from one side of the piston to the other when the aileron is moved manually.

• **Tail Jet Controls Pitch**—The tail jet is a long, external tailpipe that conveys thrust to the tail from the jet control engine. The tail jet diverter is moved by a single hydraulic cylinder, the same type used to actuate the ailerons. The diverter is connected to the eleva-

FIG. 5. FLOW DELIVERY CURVE for each main pump delivers 27 gpm up to a pressure of 2700 psi. Then its displacement decreases to zero as pressure rises to 3100 psi.

FLOW REQUIREMENTS FOR X-18 HYDRAULIC OPERATIONS.

Operation	System	Main System Delivery—gpm	Auxiliary System Delivery—gpm
Ground-Taxi	Nose wheel steering and brakes	———	3
	Electrical a-c generator drives	9	9
Total		9 gpm	12 gpm
Flight	Aileron & tail jet diverter	1.5	1.5
	Wing-tilt max.	15.0	15.0
	Electrical a-c generator drives	9.0	9.0
Total		25.5 gpm	25.5 gpm

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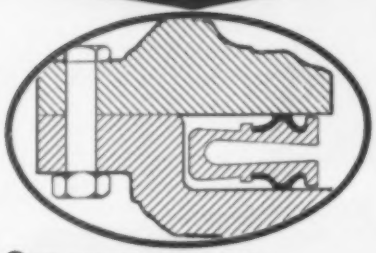

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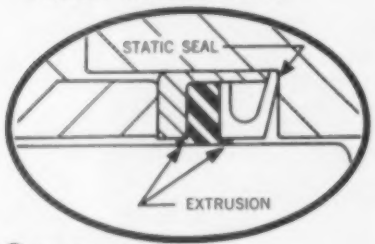
- A flexible metallic ring with protruding Teflon sealing edges. Uses inherent spring property of the metal ring and the pressure being sealed to force a tight joint.
- Temperature range from —450°F to 500°F at pressures up to 5000 PSI. Re-usable. Requires only light flange loading.



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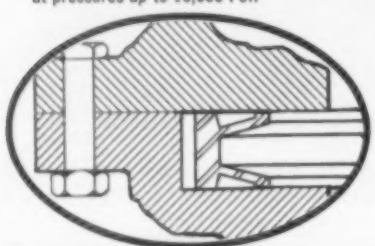

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tor control system, so that they operate together. The diverter control input is from the pilot's column, and the diverter operates even when there is no tail jet.

• **Hydraulic Motor Drives Generator**—Each system has a 6000-rpm fluid motor driving an a-c generator. A flow limiter in series with the generator drive motor prevents overspeeding.

The main gear brakes are hydraulically operated at 1500 psi. Each wheel has a shuttle valve to allow the emergency pneumatic system to operate the brakes in case of hydraulic system failure.

Hydraulically powered nose wheel steering is provided. When a solenoid valve is energized to open, the *steer-damp* actuator steers the nose gear through a cable control from a small wheel inside the pilot's control wheel.

Wing tilting, aileron control, tail jet diverter control, and a-c generator drive are primary functions, and are supplied by both the main and utility power supply. Nose wheel steering and main gear brakes are considered secondary, and draw from the utility power supply only.

Standard AN flare type connections are used throughout. High pressure lines are annealed, corrosion resistant steel. Low pressure lines (under 1500 psi) are 52S0 aluminum alloy.

▼▼▼

SAVING COSTS IN COMPONENT DEVELOPMENT

Besides being the largest (16½ tons) tilt wing airplane ever built, Hiller's X-18 development was a radical departure from conventional, experimental engineering.

An experimental military plane usually calls for all-new components for its hydraulic system—many specially designed, all expensive. The X-18 development was different.

The airplane is a "flying breadboard" of experimental hydraulic circuitry. Some systems salvaged from other aircraft and even non-flying systems were re-worked to fit its specifications.

The two wing tilt cylinders are an outstanding example. When preliminary engineering drawings were completed, Hiller began scouting manufacturers for construction of the experimental cylinders. To their amazement, they were invited by Interstate Engineering Corp. of Anaheim, California, to go to their warehouse and "take your pick". They found the room stacked with cylinders Interstate had produced for the Nike missile launcher. The cylinders almost precisely met dimensions indicated for the X-18 and even had a piston down-lock system. They were "surplus" and available.

Hiller bought a dozen at $700 each. Interstate estimates that engineering and testing a new cylinder would have cost as much as $18,000. Only minor modification of the Nike cylinder was required, primarily a reduction of piston stroke from 39⅝ in. to 34¾ in. by inserting a block bar. Also they enlarged the ports and replaced the upper rod-end bearing.

The wing tilt control was originally designed as a 4-way, landing gear valve for the B-58. The vendor modified the spool and sleeve to get the metering required for the X-18.

Another cost reduction was achieved by salvaging the landing hydraulic system of the surplus plane which was used for the structural foundation of the X-18's airframe.

Hiller found that the hydraulic rudder actuators designed for the F-11-F Grumman airplane could be used as actuators for the four ailerons. These cylinders have integral servovalves, which were modified by adding valve centering springs.

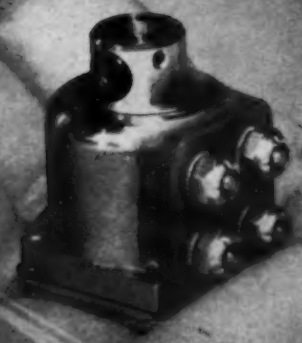
The main return line filter was used on the Boeing 707. It has a by-pass relief valve and associated check valves. The pressurized reservoir was designed for the F8U Chance Vought airplane.

The main gear hydraulic brakes are left over from a Chase aircraft, 1500-psi system. The nose wheel steering system is unchanged from the same aircraft.

Hiller's experience in developing the X-18 under limited military appropriation has shown the desirability of using existing hardware to eliminate costs of manufacturing and test-certifying new-design components.

Circle 151 →

Watch Weston for new concepts...



This miniature, electro hot-gas servo valve developed by Weston for the U.S. Army's "Mauler" Missile weighs only .18 pound.

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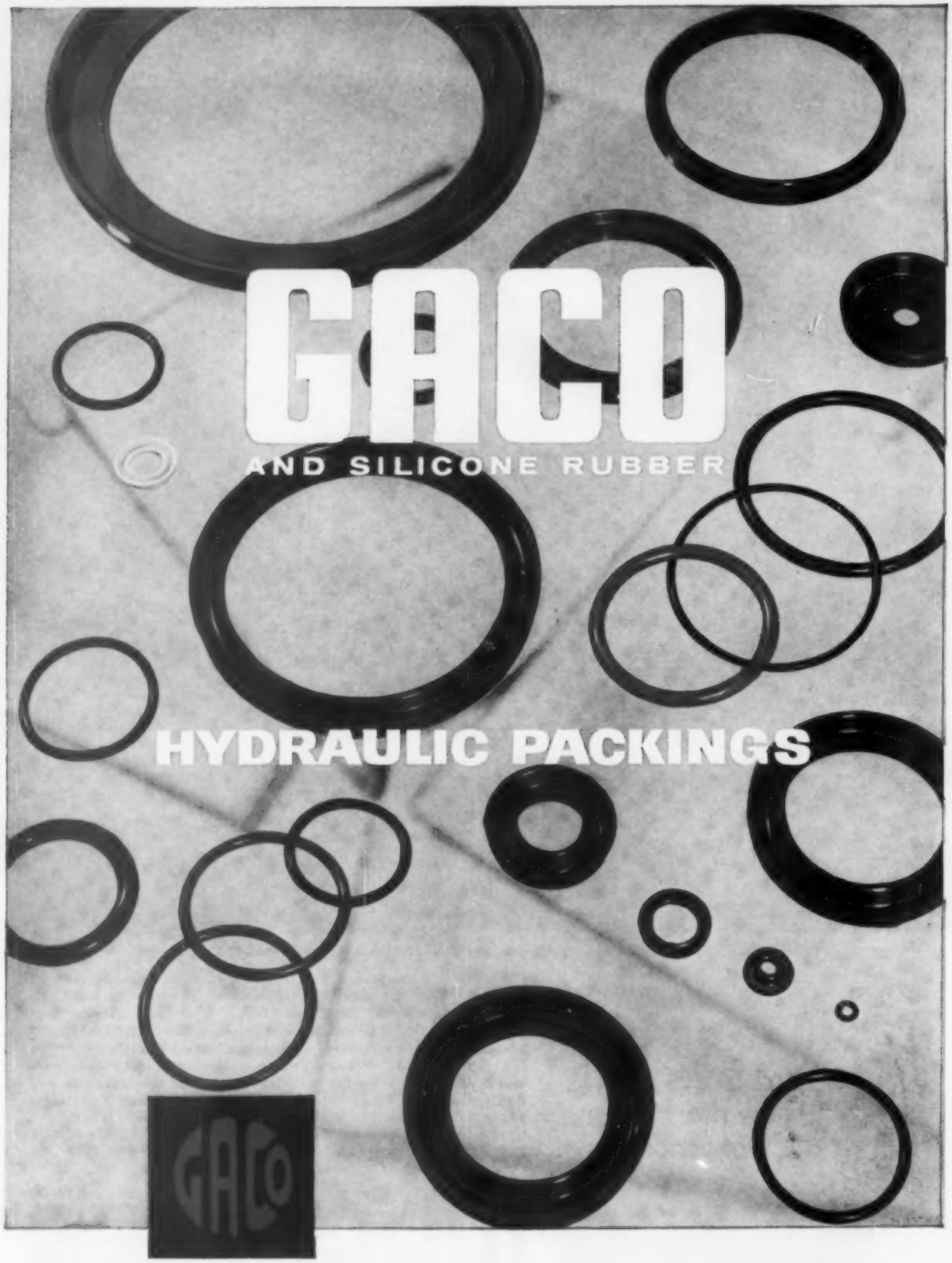
Mauler is being developed by Convair/Pomona, Convair Division of General Dynamics, for the Army Rocket and Guided Missile Agency, an element of the Army Ordnance Missile Command.



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A63

AEROSPACE NEWS

from the fluid power field

Astronaut's "Cherry Picker" is hydraulically controlled

Eight hydraulic cylinders position the two-section, 112-foot mobile tower which was on stand-by until the last moments before the Mercury capsule firing, ready to receive the astronaut in case of delays or emergency situations. Developed by Mobile Aerial Towers of Ft. Wayne and Commercial Shearing & Stamping of Youngstown, the tower is mounted on a 17-ton truck and has a completely enclosed gondola at the end of the boom. Live load capacity is 1250 pounds. The tower's height caused complex problems in stability, twisting, and smoothness and sureness of control. The enclosed gondola increased wind resistance and required outriggers on the truck.

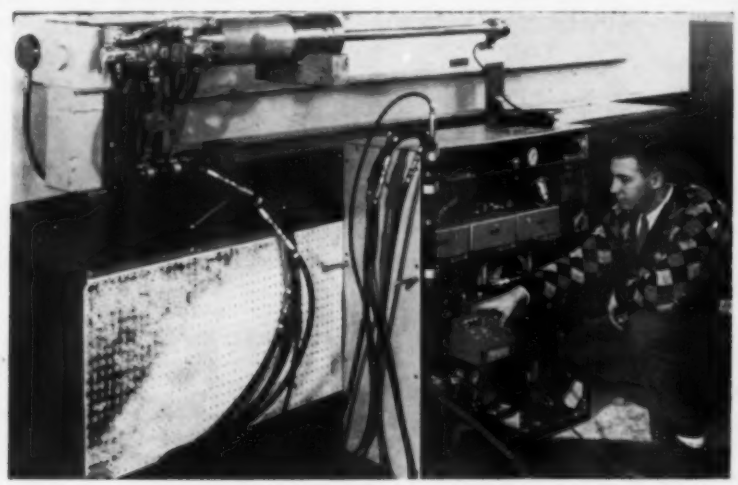
The lower boom section is positioned by two 60-inch stroke cylinders, each with 67,000 lb push stroke. Two 64-inch stroke cylinders, each with 50,000 lb push, manuever the upper section. The remaining four, 29½-inch stroke cylinders actuate the outrigger stabilizers.

An important control feature is built-in position programming. Touching a single button in the gondola, truck, or blockhouse will automatically sequence the hydraulic system. It will withdraw the

Continued on next page

Accelerator tester uses liquid compressibility to develop 1000 g's

By using liquid compressibility, high energy is released to a lightweight moving part being tested, to provide high acceleration and velocities. The controlled shock absorbing characteristics of the unit stops the part without excessive g input in a short distance. The system which was developed by Tayco Developments, Inc., North Tonawanda, N. Y., has a 70-gpm valve which opens in one millisec. The linear accelerator develops from 240 to 1000 g's. A part being tested is accelerated up to 105 mph in 7 in., velocity is maintained for 24 in., then stopped in 8½ in.



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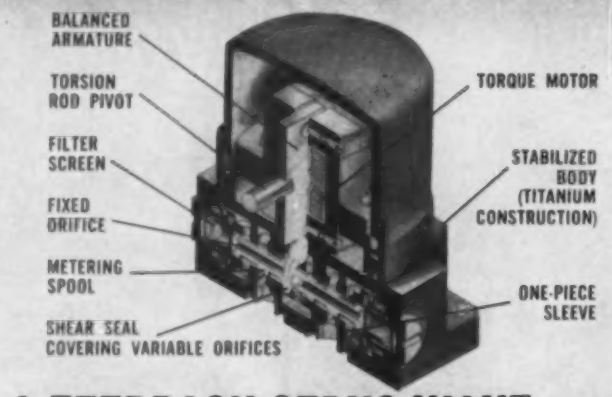

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Hydromechanical unity feedback relates spool position to torque motor armature position and also nulls out effects of orifice variations due to supply pressure and temperature fluctuations. Flow force reactions are thus substantially reduced and hydraulic centering of pilot position is feasible without spring hysteresis and null shift. Large orifices prevent clogging and silting and high shear forces permit efficient operation even with highly contaminated fluids. Final null adjustments are made electrically by a balancing control at amplifier output stage.

TYPICAL CHARACTERISTICS

	Medium Flow (#6103-#6106)	High Flow (#6104)
Rated flow	to 7.5 gpm at 3000 psi valve pressure drop	to 18.0 gpm at 3000 psi valve pressure drop
Hysteresis	3% maximum total rated current	3% maximum total rated current
Supply pressure	300 to 3000 psi	300 to 4000 psi
Proof pressure	4500 psi pressure port 3000 psi return port	6000 psi pressure port 3000 psi return port
Pressure gain	First stage—500 psi per ma minimum with 3000 psi supply	First stage—500 psi per ma minimum with 3000 psi supply
Load pressure gain	8500 psi per ma minimum with 3000 psi supply	10,000 psi per ma minimum with 3000 psi supply
Temperature	—65°F to +275°F	—65°F to +275°F
Maximum Null Shift (% of rated current)		
Temperature Change per 100°F	1%	1%
Supply Pressure Variation ±	2%	2%
Quiescent Current Change 20%	1%	1%
Weight	12 ounces	16 ounces

TORQUE MOTOR: Note: 6103 & 6106 identical with exception of torque motor characteristics.

	Valve #6103	Valve #6106
Input Power	300 Milliwatts	64 Milliwatts
Rated Current	± 10 ma	± 8 ma
DC Coil Resistance (other motors also available)	3000 ohms/coil	1000 ohms/coil

Write for complete data

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AEROSPACE NEWS

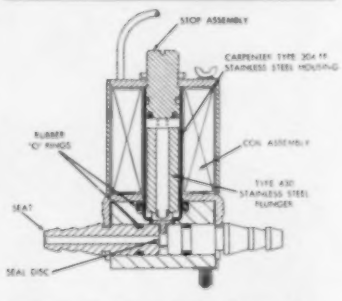
from the fluid power field

gondola from the capsule, turn it 45 degrees, and lower it to the ground, all in less than 25 seconds.

A manual override is also included. It allows the astronaut to use a single-grip, three-dimensional control to move in any direction.

Weston promotes Irwin, forms engineering group

Weston Hydraulics, Ltd., Van Nuys, Calif., has promoted Donald W. Irwin to the position of chief engineer, Aero/Space Controls. In addition, Charles E. Rees has been named chief engineer, of the newly created industrial controls engineering group. Weston recently developed a new gas servo system, and is currently working on several new industrial controls concepts for industrial applications. ▼▼▼



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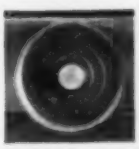

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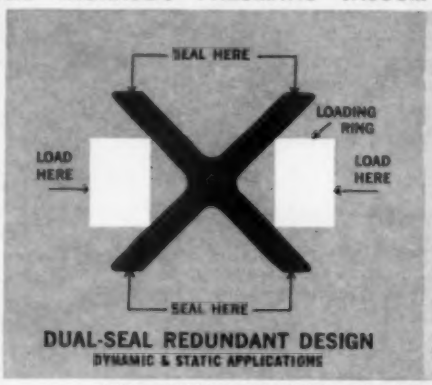

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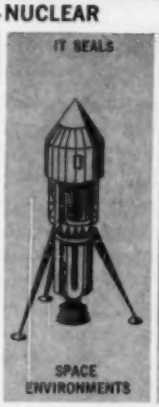

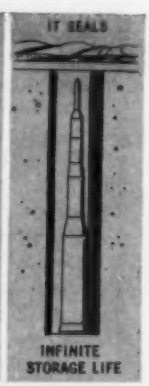

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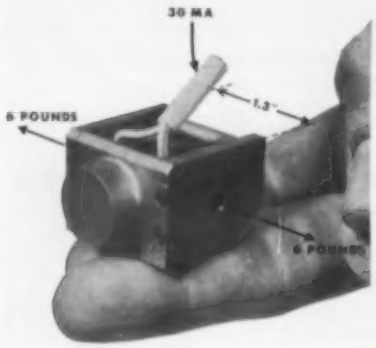
Circle **148** on Reader Service Card

• COMPACT
• LIGHTWEIGHT
• RELIABLE

MI
MIDWESTERN INSTRUMENTS

MODEL 15 LINEAR DISPLACEMENT SOLENOID



WEIGHS LESS THAN 4½ OUNCES

AN ACTUATOR THAT TRANSDUCES ELECTRICAL POWER TO MECHANICAL FORCE OR MOVEMENT

The Midwestern Model 15 Linear Displacement Solenoid is so small and so light . . . it's ideal for applications requiring relatively small, high-force displacements proportional to input signals . . . is highly effective in automatic timing, cycling devices requiring linear mechanical motion for outputs . . . is applicable to systems incorporating electrical feedback to maintain a quiescent level of operation. It operates dependably in environmental temperatures to 400° F., is submersible in fluid or gas—couples efficiently with servo valves in hydraulic control systems, and assures precise, accurate control of the new improved electrical-position indicating instruments.

Write Dept. HP

MIDWESTERN INSTRUMENTS
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TULSA 18, OKLAHOMA

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AEROSPACE COMPONENT DATA

Gas Booster Compressor

Features: Designed on the concept that best way to avoid gas system contamination is to dry-compress

gas. This eliminates lubricant removal and gas purity systems. No excessive filter cleaning, purification cartridge replacement, and oxygen compatible lubricants. Uses include production gas testing, ground support equipment, receiving inspection departments, LOX cleaning rooms, and laboratories.

Specifications: Single-stage to 6:1 compression ratio. Two-stage to 16:1. To 10,000 psig, 14 scfm. 80 to 150-psig plant air pressure boosts bottled gas to 10,000 psig without water or hydraulic barriers, or thin diaphragms for gas systems.

Designation: Model AG Series.—*Haskel Engineering & Supply Co., Glendale, Calif.*

Circle **500** on Reader Service Card

Pressure Transducer

Features: All stainless steel pressure transducer for precise pressure measurement in a confined space. Uses welded, Ni Span C pressure

element linked inductively to an ultra-sensitive differential transformer. Provides high continuous output with exceptional repeatability and low acceleration response.

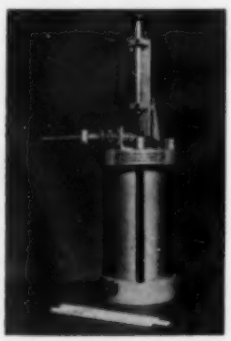
Specifications: O. D. is 1¼ in. Available in ranges from 0-5 to 0-350 psi, gage, absolute, or differential. Temperatures from −115 F to 500 F.

Designation: Type 78-C.—*United Aero Products Corp., Burlington, N. J.*

Circle **501** on Reader Service Card

Precision Measuring & Testing Instruments

Brochure describes electro-hydraulic and electropneumatic meas-



uring and testing instruments and test stands for aerospace and fluid power components. An extensive description of each instrument is presented together with specifications, design features, envelope dimensions, a block diagram of the instrument's circuit, and variations possible with special assemblies. Under flow generation and measuring instruments are listed metering cylinder assemblies of several types and volume differentiating (dV/dt) flowmeters. Some servovalve test instruments are, for static measurement: valve flow analyzer, mechanical drive unit, and pressure plotting. For dynamic response measurement: valve dynamic analyzers (control cabinet and test actuator assembly). Servo package testing is described.—*Industrial Measurements Corp., Pomona, Calif.*

Circle **502** on Reader Service Card

Continued on page 122

Circle **47** on Reader Service Card

Looking for a standard microfilter rated up to (or above) 10,000 psi?

LOOK INTO THIS FD DESIGN**

Note (1) flow contoured inlet; (2) eccentric location of outlet; (3) deflection surface that guides stream around element. Result? At 10,000 psi inlet pressure, ½-inch filter passes 1000 SCFM (nitrogen at 70°F) without pushing ΔP above 50 psi. Dynaloy* C sintered stainless steel element removes 98% of all 10-micron particles (finer or coarser elements also supplied). Unit handles fluids from −320°F to +400°F. Available in ¼-inch to 1-inch sizes. Minimum burst pressure 36,000 psi. For detail sheet, for brochure (D-5), please write.

*Trade name of FLUID DYNAMICS Incorporated **Pat. Applied for

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Dept. HP-7, 90 West St., New York 6, N.Y.

Available from Stock!
NEW, INEXPENSIVE, LIGHTWEIGHT ORDNANCE CRYOGENIC COUPLINGS from FUTURECRAFT

Patent Number 2971782

Now you can replace obsolete cryogenic couplings with these new screw type units from Futurecraft—and connect flex lines, tubing or pipe quickly, easily and *safely fluid-tight.*

These couplings—service proven on Ordnance projects—are pressure rated at 150 psi operating, 300 psi proof and 450 psi minimum burst. Only low torque is required for a safe, tight seal. These Futurecraft couplings are available from stock in sizes from 1" to 4" in ½" increments, LOX cleaned and packaged. Installation tools are available.

Write for complete details

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Circle **52** on Reader Service Card

CIRCLE SEAL GAUGE PROTECTOR

SERIES 1100

A safety shield for gauges and personnel, the Circle Seal Gauge Protector is designed for pneumatic or other gas systems as well as liquid service. Use of contact rather than sliding seals overcomes O-Ring breakaway friction problems associated with piston type units. Automatic cut-out when system pressure exceeds gauge limit...automatic cut-in when system pressure returns to normal maximum. In gas systems, surge or shock waves will close valve momentarily to reduce shock to gauge elements. Where gauges are cascaded, Gauge Protector automatically cuts out lower pressure gauges...cuts them in as system pressure falls.

PREVENTS COSTLY DAMAGE ...AUTOMATIC GAUGE CUT-OUT

From 15 to 2400 psi...—100° to 500°F. Wide range of cut-out pressure settings. Available in brass or 303 stainless.

Military Service:
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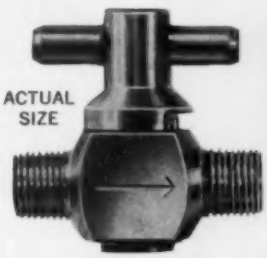
Industrial Service:
CIRCLE SEAL PRODUCTS CO., INC.
2181 East Foothill Blvd., Pasadena, Calif.

CIRCLE SEAL precision valves



CIRCLE SEAL MINIATURE PLUG VALVE

SERIES 9500

Miniaturized at no sacrifice in quality, the Circle Seal 9500 Series is ideal for application in instrumentation, inert gas test stands, hydraulic clamps, jacks, etc. The convenient "T" handle with 90° actuation provides effortless opening and closing. The handle is color coded for various gases and liquid service requirements. The visual indication provided by the "T" handle can be used as a metering device by turning the handle various degrees from full-on to full-off. "O"-Ring seals virtually eliminate wear. When required, simple repair is effected by replacing three "O"-Rings without removing valve from the line.

ABSOLUTELY LEAKPROOF ...EFFORTLESS CONTROL

Positive sealing from high vacuum to 2000 psi. Male or female connections in ⅛" or ¼" sizes. Brass or 303 stainless.

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CIRCLE SEAL precision valves

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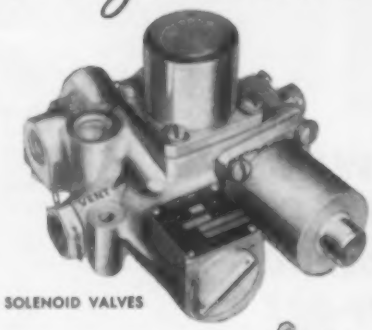

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PRESSURE REDUCERS

Other valves and systems available

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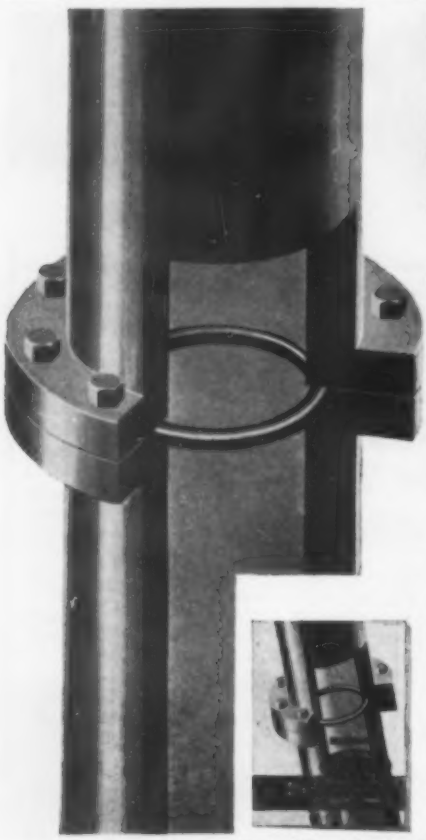


POSITIVE SEALS

−452° to 3000° F.

United Self-Energized Metallic O-Rings*...

form permanent, non-corrosive, static seals under temperature extremes from −452° to 3000° F. and pressures from 10^{-4} mm Hg to 100,000 psi. Available in various metals and coatings (including Teflon** and silver) ¼" O.D. dia. to any size and configuration. United also makes non-vented and pressure-filled O-rings. **United Metallic "O" Rings, manufactured by United Aircraft Products, Inc., Box 1035, Dayton, Ohio.**

See United Metallic O-Ring Catalog in Sweet's Product Design File or write for Free Handbook

*Patents 2,809,269; 2,837,360
**DuPont registered trademark

Circle **141** on Reader Service Card

AEROSPACE COMPONENT DATA

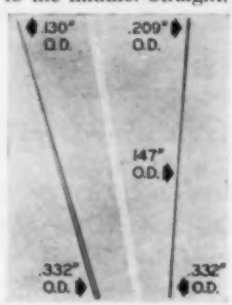
Gas Dehydration & Purification

Booklet describes and specifies gas dehydration and purification equipment. Graph in data section shows water content of saturated air at temperatures from −75 F to 200 F and pressures to 14,000 psi. Special table converts ppm/w to ppm/v and vice versa of H_2O and HC to C_1 to C_8 in various parent gases. Descriptions include cartridge and refrigerator systems, mechanical filters, cartridge chambers, cartridges, and vapor and dewpoint indicators. Also new dynamic flow-type and cabinet dehydrators. Equipment specifications are to 12,000 psi, dewpoints to −120 F, safety factor is 4 to 1, and oil vapor and other hydrocarbons removed to less than 1 ppm/w.—*Robbins Aviation, Inc., Los Angeles.*

Circle **503** on Reader Service Card

Taper Tubing

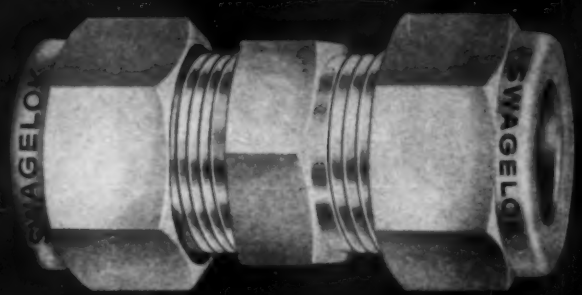
Features: Straight or reverse taper tubing furnished with either constant or tapered wall in lengths to 10 ft. Reverse tubing supplied in two forms: tapered from the middle to ends or tapered from the ends to the middle. Straight, is tapered continuously from one end to the other. Close tolerances and freedom from ID cracks make it useful for thrust chamber tubing in missiles and rockets.



Specifications: Available in any material readily cold worked, including carbon, alloy, and stainless steels; nickel and nickel alloys; beryllium copper; and titanium and other reactive metals. Surface finish to 65 microinches or better.—*Superior Tube Co., Norristown, Pa.*

Circle **504** on Reader Service Card

WHY WAS THIS TUBE FITTING MADE FROM PLATINUM?



This Swagelok tube fitting was machined from Platinum because that is what our customer needed for his nuclear reactor experiments. This is just one of many outstanding examples of Swagelok customer service. The scientist who needed this fitting knew that Swagelok tube fitting reliability would meet the exacting requirements of leak tightness for nuclear work. He also knew that full cooperation in delivering Swagelok in any machineable metal is routine.

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Circle 57 on Reader Service Card

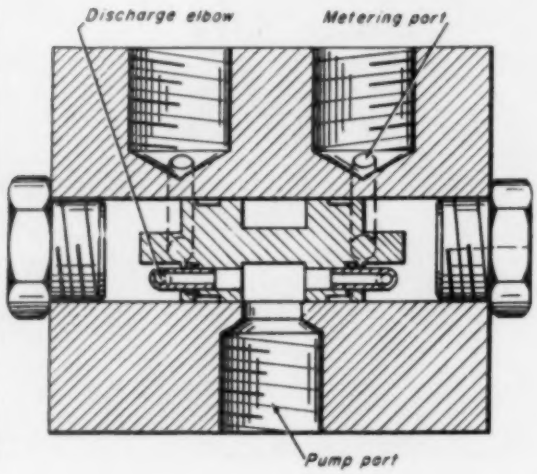
FLUID POWER PATENTS

Flow Divider With "Live" Spool

Rotational dither keeps the spool of this valve alive so that it can be easily and accurately positioned. Reaction to fluid flow through the spool provides a turning moment which rotates the spool.

• **Operation**—Fluid enters the valve through the pump port and flows through the openings in the spool lands. These openings terminate in 90-degree elbows. Both elbows discharge in the same direction causing a rotational force at the periphery of the spool. Flow from these elbows passes through metering ports to the cylinders or fluid motors being synchronized.

The metering ports pass equal flow regardless of load pressures at each port. If pressure from the load increases at the port on the right, the spool moves



left decreasing resistance to flow through the right port, and increasing flow resistance through the left port. This spool movement decreases pressure right of the spool and increases pressure left of the spool. These pressure changes equalize the pressure drop across the discharge elbows and provide equal flow through them.

The valve spool is rotated by the reaction to fluid flowing through the discharge elbows. This movement keeps the spool "alive", reduces friction, and eliminates breakaway force, making the valve more sensitive to slight pressure changes.

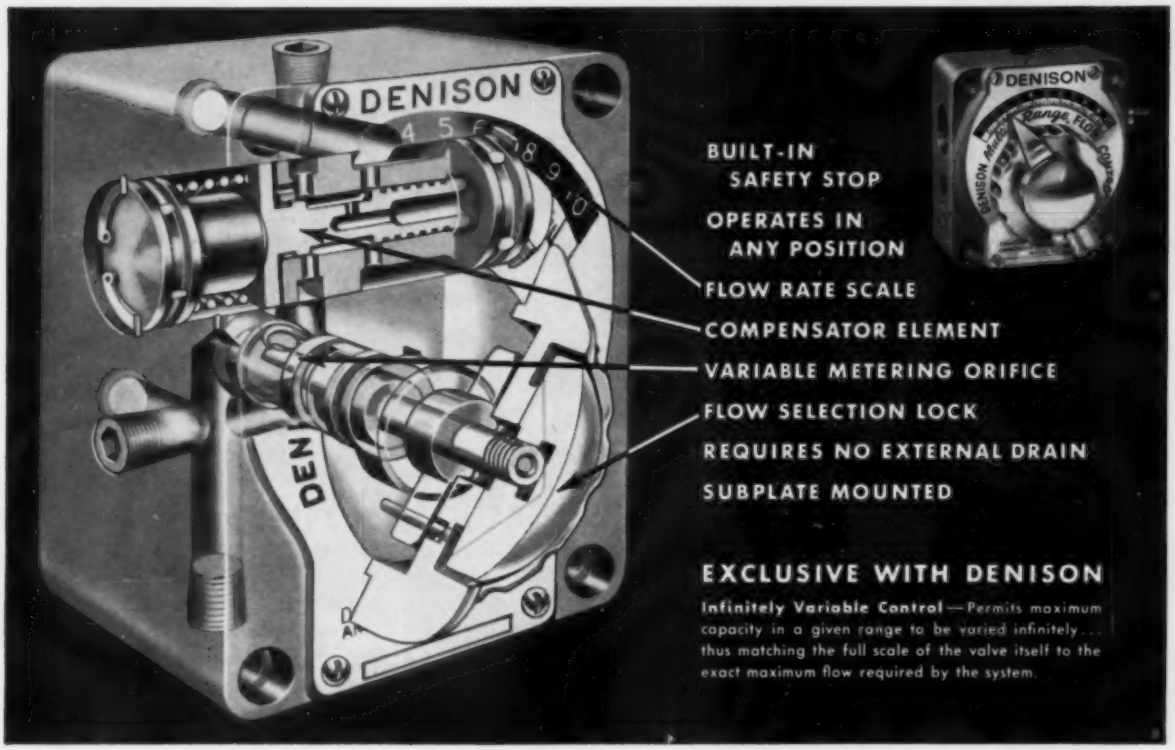
U. S. Patent No. 2,971,522 by Richard L. Lewis, assigned to The Bendix Corp., Delaware, Md.

More Patents on page 126

NEW precision FLOW CONTROL at production prices

MULTI-RANGE FLOW CONTROL

- extra-sensitive flow control adjustment for precise flow settings
- temperature-viscosity compensated...no change in selected flow rate
- important exclusive design features now in all 3 sizes...¼"–⅜"–¾"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BUILT-IN SAFETY STOP
OPERATES IN ANY POSITION
FLOW RATE SCALE
COMPENSATOR ELEMENT
VARIABLE METERING ORIFICE
FLOW SELECTION LOCK
REQUIRES NO EXTERNAL DRAIN
SUBPLATE MOUNTED
EXCLUSIVE WITH DENISON
Infinitely Variable Control—Permits maximum capacity in a given range to be varied infinitely... thus matching the full scale of the valve itself to the exact maximum flow required by the system.

Here's how to solve the problems of precise speed control... and uniform feed rate—for optimum precision work finish and cutter life for modern machine tool requirements.

With Denison's new Multi-Range Flow Control, you can count on these important exclusive design features and advantages... all pioneered through Denison advanced engineering—

PRECISE FLOW SELECTION is provided through a new, extra-sensitive control with an exceptionally wide range of adjustment in any given range.

MULTI-RANGE CONTROL—one model does the work of many to simplify inventory. Adjustments from range to range are simple, safe, foolproof—guarded by stops.

UNIFORM RATE OF FLOW is assured because Multi-Range Flow Control is virtually free from flow change due to temperature-viscosity changes.

FLOW SURGE OVERTRAVEL VIRTUALLY ELIMINATED—by simple adjustment—to avoid erratic feed of slides as the valve finds its setting.

BUILT-IN RELIEF VALVE saves space... simplifies circuits... may be remotely controlled.

BUILT-IN CHECK VALVE permits reverse free flow.

PRODUCTION PRICED . . . and built to JIC Standards for operating pressures to 2000 psi. Available in 2-port and 3-port types.

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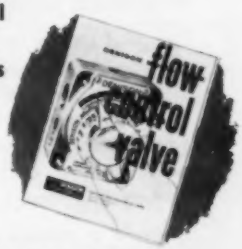
Write for full details and specifications in Bulletins VFC-3 and 143-A.



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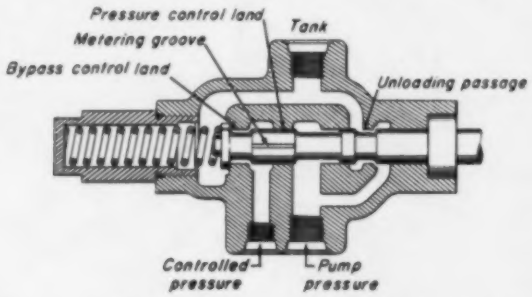
Circle **43** on Reader Service Card

Variable Pressure Control Valve

In many mobile equipment hydraulic systems, pressure to brake and clutch cylinders must be variable. This manually actuated spool valve controls fluid pressure by directing part of the fluid to the cylinder and bypassing the remainder to tank. Spool movement varies the two flows inversly.

• **Operation**—The controlled pressure port connects to a single-acting, spring-return, clutch or brake cylinder. With the valve spool held in its normal position by the spring, fluid enters the pressure port and flows to tank through the unloading port.

To apply cylinder pressure, the valve spool is moved left, closing the unloading passage and moving the metering groove to a position straddling the bypass control land and the pressure control land. Pump flow



then enters the controlled pressure chamber through the metering groove. Part of the fluid in the controlled chamber returns to tank through the metering groove. Flow in and out of the controlled chamber is a function of the length of the metering groove in contact with the valve lands.

As the plunger moves left, length of the groove through the bypass land increases and groove length through the pressure control land decreases. This movement increases pressure at the control port.
U. S. Patent No. 2,942,583 by Robert W. Rue assigned to The New York Air Brake Co., Kalamazoo, Mich.

Other Patents Issued

Servo Solenoid Valve
No. 2,977,984 by Phillip E. Barnes, assigned to United Aircraft Corp., East Hartford, Conn.

Selector Valve
No. 2,977,983 by William W. Headings, assigned to Borg-Warner Corp., Chicago, Ill.

Electro-Hydraulic Servo Mechanism
No. 2,981,273 by Bernard L. Callender, Thomas F. Graffy, Werner G. Holzbock, and Kenneth O. Rockey; assigned to GPE Controls, Inc.

Gear Pump
No. 2,981,200 by William T. Stephens, assigned to Parker-Hannifin Corp., Cleveland, Ohio.

Circle **137** →

WEAR RESISTANT
THOMSON

60 Case

AVOID the HIGH COST and difficulty of fabricating long, hard & straight parts by conventional methods!

hardened and ground

SHAFTS, ROLLS, GUIDE RODS and other long-round parts

ELIMINATE WEAR and REDUCE COST

60 Case is the result of over 15 years of experimental work and production experience with hardened and ground shafts which are a requirement for BALL BUSHINGS, the Linear Ball Bearing manufactured by Thomson Industries, Inc.

The special techniques and equipment that have been developed enable high production rates and low handling costs. This permits big savings over conventional methods which are plagued with erratic warpage, straightening and resultant grinding problems. Finished *60 Case* parts frequently cost less than the scrap losses that result from conventional methods.

60 Case material has a surface hardness close to 60 on the Rockwell C scale which is essential to resist wear.

Long lengths of material ranging in diameter from ¼" to 4" are stocked to enable prompt shipment of *60 Case* parts, with or without special machining. *Write for literature and name of your local representative.*

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ADVANTAGES of *60 Case*

- COST REDUCTION
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- NICK-& DENT-PROOF
- ACCURATE DIAMETERS
- GROUND FINISH
- STRAIGHT PARTS
- DELIVERY FROM STOCK
- ADDED STRENGTH
- UNIFORM HIGH QUALITY

TYPICAL *60 Case* PARTS

GUIDE RODS • SHAFTING • ROLLS • TRAVERSE RAILS
PISTON RODS • ARBORS • LEADER PINS • TIE RODS
KING PINS • AXLES • CONTROL RODS • GUIDE POSTS
MANDRELS • BEARING ROLLERS • SPINDLES

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Dept. C-4, Manhasset, New York

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increase life.. reduce cost!

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Use Wooster hydraulic pumps to lengthen the life of your products and greatly improve their performance—at far lower cost. *Controlled* pressure loading* is built into every Wooster pump, regardless of capacity. Internal hydraulic forces pushing against bearing faces are *exactly* counterbalanced by carefully calculated pressure from the outlet area.

*Patent Nos. 2420622, 2823615, 2824522, others applied for. In pumps without this advanced design feature, wear is accelerated and pump life shortened by undue loads on bearing faces.

P2 SERIES HYDRAULIC PUMP

Capacities 1.7 to 6.8 GPM at 2000 RPM and 2000 PSI
Displacement 0.2 to 0.85 cu. in.
Speeds to 4000 RPM

Special alloy tin-aluminum bearings, all interchangeable . . . double lip shaft seal . . . hardened and ground steel gears and shafts . . . high quality, high tensile aluminum bodies. A variety of porting, mounting and drive arrangements.

WOOSTER DIVISION BW
BORG-WARNER CORPORATION
WOOSTER, OHIO

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NEW PRODUCTS

Continued from page 54

ROTATING FLUID TRANSFER UNIT

For transferring fluids from a stationary source to a rotating hollow spindle. Applications include gun-drill, clutch, and power cylinder.

Specifications: Withstands cycling or steady pressures to 1200 psi at speeds to 12,000 rpm.—*Sealol, Inc., Providence.*

Circle **308** on Reader Service Card

MINIATURE VALVES

Straight pattern, forged body for compact use in instrument design. Panel mounting. Colored handles

permit color coding. Teflon cylinder packing. Micro-regulating and non-regulating stems.

Specifications: Fits connections for ⅛" O.D. tubing. In brass and type 316 stainless steel. 2¾" high. Pressures to 3000 psi. Orifice is .080". Straight and angle pattern available with ¼" male pipe ends.

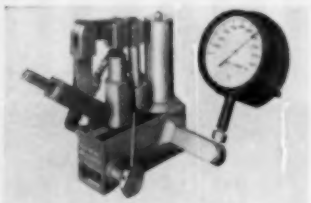
Designation: Series O.—*Whitey Research Tool Co., Oakland.*

Circle **311** on Reader Service Card

HAND PUMP

For high pressure static testing. Uses compound leverage principle to get extreme pressures. Bubble tight, self-sealing valves and release screw. Intake and pressure release valves contained within unit.

Specifications: Pressures to 50,000 psi. Has maintained 65,000 psi continuously for 100 hours.



Only gauge variation was due to atmospheric temperature. Has ¾" piston, ¾" stroke. Piston, barrel, and valve block are heat treated alloy steel.

Designation: Model 50M.—*Wm. S. Pine, Inc., Los Angeles.*

Circle **312** on Reader Service Card

MODULAR MANIFOLD BASE

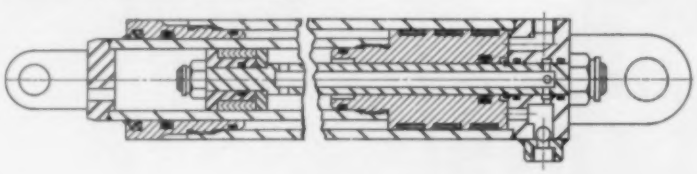
Features common supply, exhaust, and wiring conduit ports. Can be ganged end-to-end to manifold two or more valves in a single unit.

Continued on page 130

DOUBLE-ACTING CYLINDER, ONE PRESSURE PORT

Basically a single-acting cylinder in extension direction. Internal, double-acting action subtracts I.D. area of plunger tube, so effective area of unit in extension is actually plunger tube wall area. Effective area for retraction is rod side area of small internal double-acting cylinder. By sizing feed rod properly, these areas can be made equal and cylinder will move at same speed in both directions. Stroke is 127".—*Universal Hydraulics, Willoughby, Ohio.*

Circle **310** on Reader Service Card



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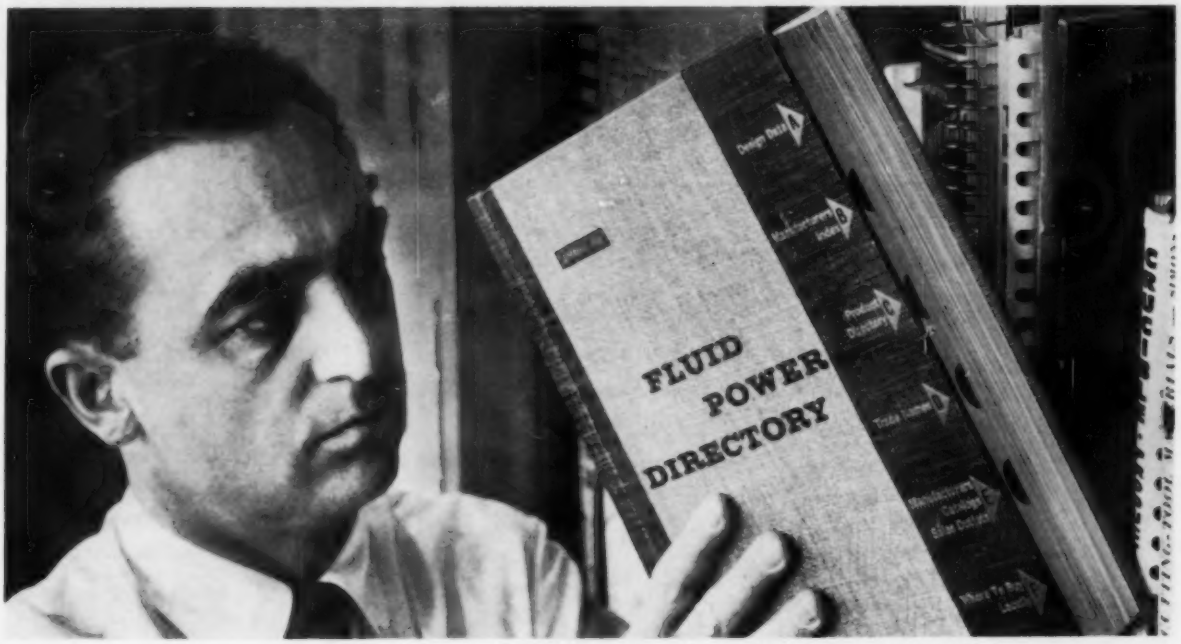

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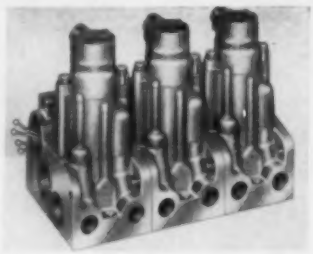

base, plug-in. Bayonet-lock construction permits removal and installation of valve and pilot assembly in 30 seconds.

Specifications: For mounting ¾" PDQ control valves. Side and bottom tapped cylinder ports, ⅜", ½", or ¾" NPT. Supply port tapped both ends and bottom, 1" NPT. Exhaust and wiring conduit ports ends and bottom tapped 1¼" NPT. Cast aluminum.—*Hunt Valve Co., Salem, Ohio.*

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Non-skive hose. Progressive swaged end fittings for maximum reliability include male pipe, JIC and SAE swivel configurations. Adapters available. Available as complete assemblies, or as bulk hose and fittings. New swaging tool with interchangeable dies is suitable for Teflon and rubber hose.

Specifications: ¼" to 2" dia. Medium-pressure assemblies for 3000 psi; high-pressure, 5000 psi.—*Titeflex, Inc., Springfield, Mass.*

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CHECK VALVE

Assures O-ring reliability against high pressure split-second surge flows. Restrains O-ring from wash-

out. Rugged body construction gives additional failure protection. Dead tight sealing and chatter-free operation. For use in high pressure

Continued on page 132

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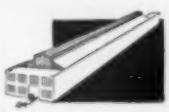

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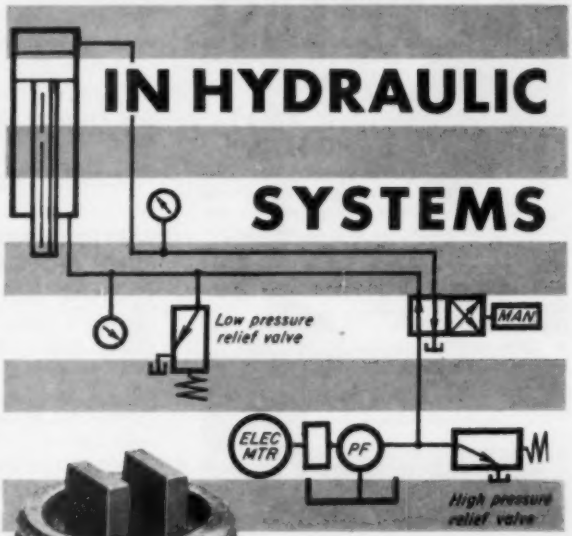

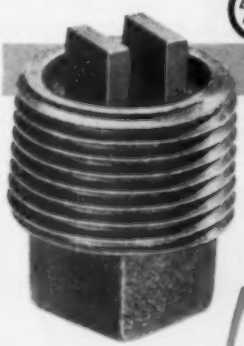

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services which have extreme surge flows.

Specifications: Brass, aluminum, steel, and stainless steel bodies. Sizes from ¼" to 2".

Designation: 200 series.—*Circle Seal Products Co., Inc., Pasadena, Calif.*

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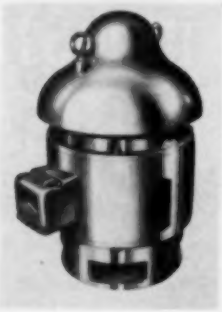
VERTICAL HOLLOW SHAFT PUMP MOTOR

Used with centrifugal pumps. Applications include circulating anodizing tanks, spray booths, and emergency, in-plant water systems. Special weather protection provided. All windings impregnated with special varnish, then permanently cemented into a single solid mass by a double-immersion and baking process. Grease fittings located for direct feed to each bearing. Dynamic balancing assures no vibration. For standard, medium, and heavy thrust uses, depending on water lifting distance. In drip-proof or totally enclosed types.



Specifications: 1 to 30 hp. Frame sizes from 225 to 326 U.—*Reuland Electric Co., Alhambra, Calif.*

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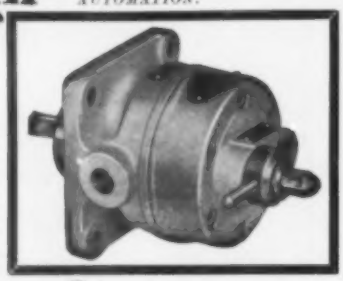
X-SHAPED SEAL RING

Combines rubber O-ring characteristics with Teflon physical properties. Installs with little seal contact pressure or interference. X-shaped cross-section has lips designed to permit flexing. Needs no lubrication. Low break-away friction. Inert to chemical attack. No aging deterioration. Primary uses

The Savery Variable Delivery Pump gives FLEXIBLE control which is completely POSITIVE over a wide range for use on hydraulically controlled Machinery, Agricultural and Factory lifting gear, Oil Burner equipment and hydraulics for AUTOMATION.



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NEW! 3-WAY PROTECTION for pressure instruments plant personnel

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- Instrument and snubber will not corrode, plug or clog
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Used with corrosive and/or viscous materials, Chemiquip's new combination also assures:

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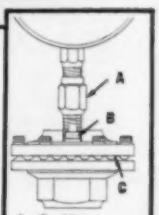
And Chemiquip's snubber smooths line surges, pulsations — gives accurate readings in 2-3 seconds.

2 and 3 piece assemblies for systems to 2000 PSI



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B—Porous S.S Disc
C—Diaphragm

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include transmissions, valves, valve seats, cylinders, and power steering mechanisms.

Specifications: Temperatures from −300 F to 500 F. Sizes from .114" I.D. to 4.475" I.D.

Designation: X-Seal.—*Allegheny Plastics, Inc., Coraopolis, Pa.*

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SUBMINIATURE SOLENOID VALVES

Photo shows one of these valves with present, standard 3-way valve.

Specifications: Stainless steel. 1" dia., 2¼" height. Weight 5 oz. 3-way NC. 3/64" orifices. Fluid connections are 1/16" PTF (short dryseal thread). Adapters provided for standard ⅛" flared tube. Operating differential pressures from 5-micron vacuum to 150 psi. Flow 4 cfm air, 0.6 gpm water. Cycle to 600 cpm. Use 7 watts. On ac, take 4 milliseconds to open, 4.5 ms to close. On dc, 10 ms to open, 16 ms to close. Over 25 million cycles with liquid, 10 million with lubricated gas, 500,000 with dry air.

Designation: B series.—*Skinner Electric Valve Div., Skinner Precision Industries, Inc., New Britian, Conn.*

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HIGH PRESSURE SHUTOFF VALVE

Precision stem fits resilient O-ring for dead tight sealing. Spring-loaded sleeve follows stem as it is withdrawn. Sleeve encloses O-ring and protects it against extrusion and fluid flow cutting action. Stem and seat permit gradual throttling of flow as valve is actuated. Single inlet and outlet featured in R900 valve. Single inlet and two outlets in Y900. Two inlets and single outlet in Z900.

Specifications: Stainless steel construction. Buna N, Neoprene or

Continued on next page

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- "DOUBLE MAGNETIZATION"
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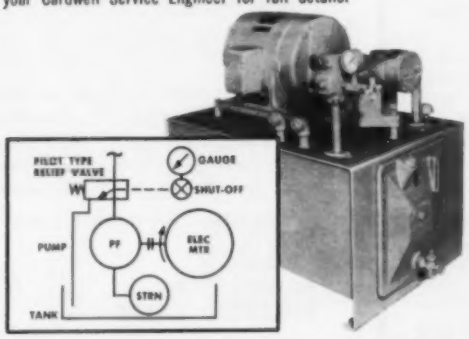

Model: PFB Single—100 Series—2000 PSI Max.
Tank Capacity: 30 or 60 gal.
Pump Delivery: 1,5-11 GPM @ 0 PSI, 2000 RPM
2.2-16.5 GPM @ 0 PSI, 1800 RPM
Motor Horsepower: As required

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SYNFLEX *Pressure Hose*

Improved hydraulic hose incorporating precision-drawn nylon inner tube, nonmetallic-reinforcing braid, abrasion-resistant extruded cover. Electrical non-conductor.

■ **Synflex Pressure Hose** is a new concept in high pressure hose for multi-purpose applications. Combines strength with light weight . . . no metal to fatigue . . . low cost. Use with water, fuels, oils, gases, solvents, refrigerants, conventional and non-flammable hydraulic fluids. Available with reusable couplings in a range of sizes from 3/16 thru ¾ ID and larger. A-1609-A

SYNFLEX
Products Div.
Samuel Moore & Co.
Mantua, Ohio

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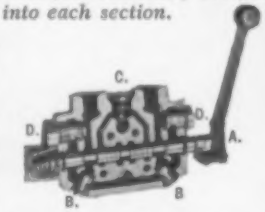
DESIGNERS:

"Here's everything you want in a multi-spool valve."

For heavy-duty mobile applications.

SECTIONAL CONSTRUCTION

with full versatility designed into each section.



A. Handle may be located at either end.
B. Anticavitation checks optional at one or both cylinder ports.
C. Load-checks in all sections.
D. Either ball-spring or pilot-type cylinder port relief optional in one or both ports.
E. Left end section includes inlet and outlet at either top or side option of ball-spring or pilot-type main relief.
F. Right end section options: Power-beyond, conversion plug, outlet or closed-center plug.
G. Individual sections may be replaced or added in the field.

Now you can specify Gresen Directional Control Valves in banks of 2, 3, 4 . . . as many as eight sections, with any combination of features in each section. Take your choice of 3-way, 4-way, free-flow or 4-position float sections in any arrangement, then add the options shown at the left.

Available port sizes: ½", ¾", or 1" NPTF, or SAE Nos. 8, 10, 12, or 14 (outlet ports to SAE No. 16). Maximum pressure: 2500 psi. Capacity: 35 gpm. Ask about models 25P and 25PK.

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Ranges: 15—30—60—100—160—200—300—600 and 1000 lbs. Also 30" vacuum. All gauges 2½" dial; ¼" bottom connection.

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Two types covering wide range of needs available: Type 11 with copper-alloy bourdon tube, silver brazed, and bronze-bushed movement. Type 11S with 316 stainless steel bourdon tube and 303 stainless tip and socket; stainless steel and monel movement.

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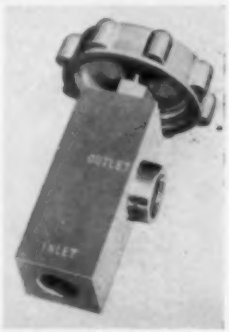
NEW PRODUCTS

Viton A O-rings. Temperatures from −40 F to 450 F. Pressures to



6000 psi. 20 in.-lb. force actuates valve under full pressure. **Designation:** 900 Series.—*Circle Seal Products Co., Inc., Pasadena.*

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AIR, HYDRAULIC CYLINDERS

For jigs, fixtures and automatic equipment. Compactness and strength achieved through fine thread, screwed construction. Replaceable parts and seals.

Specifications: ¾" bore. 250-psi air, 2500-psi hydraulic. In 1" stroke spring return and 1", 2", 3", 5", 7", and 9" double-acting models. Power factor .60, giving 60-lbs force

at 100 psi; 1500-lbs force at 2500 psi. Shaft extension 1", threaded ¼-28 x ⅜". Standard ¼" NPT ports on cylinder side.—*Clippard Instrument Laboratory, Inc., Cincinnati.*

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POPPET TYPE SOLENOID VALVE

Two-way solenoid valve for 3000-psi oil pressure. Normally open and normally closed operation. Pilot-operated, poppet type in cartridge form. Can adapt to any manifold or sub-plate. All standard a-c or d-c solenoids are interchangeable. Poppet and plunger are only moving parts, making valves less sus-

Continued on page 136

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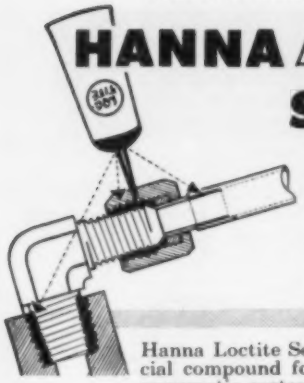

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Hanna Loctite Sealant, Grade 1, is a special compound for making hydraulic and pneumatic systems leak-free regardless of fluid used or pressure. It is a thin liquid, easy to apply and very economical.

ADVANTAGES:

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- Seals high and low pressure fluids including fire resistant types
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- Eliminates fire hazard due to escaping fluids
- Economical—a little goes a long way
- Easy to use—handy applicator bottles, tubes and capsules
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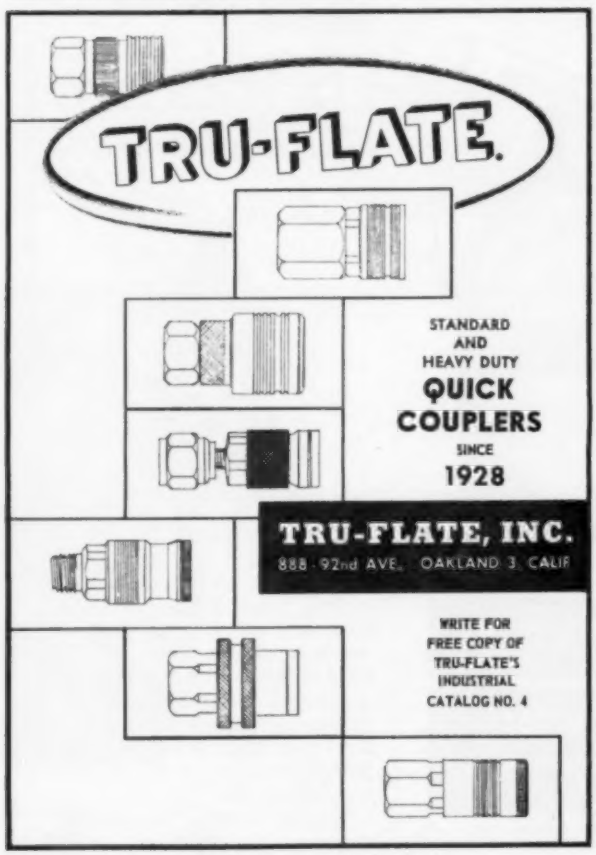

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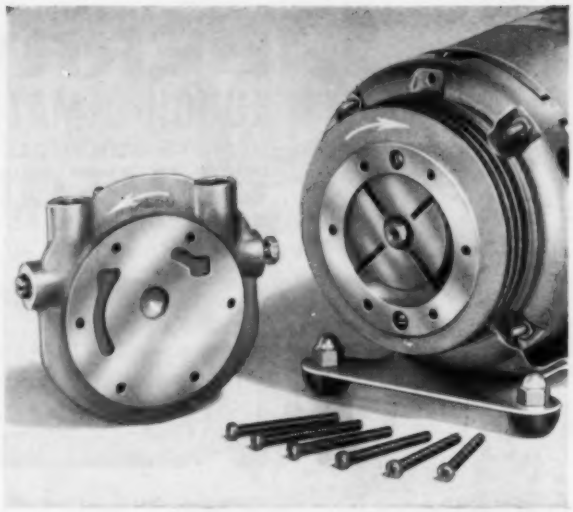

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GAST OIL-LESS* AIR PUMPS

You gain five advantages when you specify Gast Oil-less Air Compressors or Vacuum Pumps.

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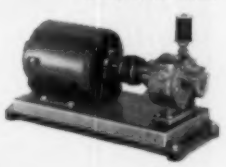
5. Oil-less design adds a sales feature to your product!

How is this possible? Rotary design has carbon vanes that lubricate themselves. Ball bearings are grease-sealed for life and located outside the pumping chamber. Simple construction assures long, trouble-free dependability.

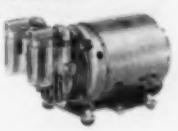
Ten sizes; capacities from .35 up to 24 c.f.m. running open. For medium duty to 10 p.s.i.g. pressure or 20" Hg vacuum. For use on instruments, medical and laboratory equipment, food packaging and paper-handling machines, Gast Oil-less Air Pumps have much to offer.

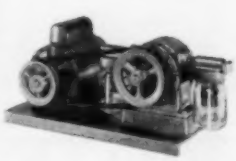
Miniature models, .35 to 1 c.f.m.

Direct coupling drive, to 5.9 c.f.m.



Integral-motor types to 1.1 c.f.m.





V-belt drives, up to 24 c.f.m.

*A wide range of lubricated models also available.

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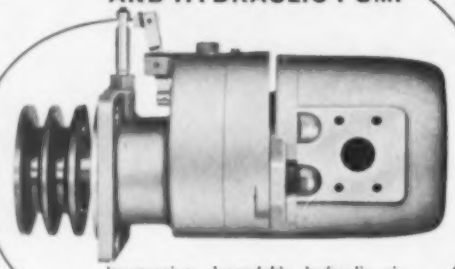
TOUCH-O-MATIC
REMOTE CONTROLLED
CLUTCH
AND HYDRAULIC PUMP



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ELIMINATES NEED FOR PTO

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Engagement speeds from idle to 2200 RPM (no load speeds)
Flow rate: 1.7 to 26 GPM
H. P. output: ½ to 30 H. P.

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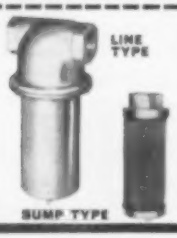
Capital's "GUARDIAN"
FILTER FLOW METER
WARNS
when filter needs cleaning!

A NEW Hydraulic Filter Flow Meter, equipped with a built-in device which warns by turning on a red light when liquid flow falls below a pre-set volume.

This new Capital "GUARDIAN" Filter Flow Meter can be set to turn on light or to turn off power supply to equipment until filter is cleaned or replaced. It is a time saving device that protects costly machinery from damage. It is entirely automatic in operation.

Using a by-pass defeats the purpose of the filter because it permits a great deal of harmful foreign matter to enter into the system when fluid by-passes the filter screen.

CAPITAL'S ALL PURPOSE FILTERS



Capital All Purpose Filters include Reservoir and Line Types with Mono-Bilt and Mono-Econo Monel Metal inserts.

Capital Filters are impervious to Hydraulic Fluids, Fuel Oils, Lube Oils, Coolants, Paints and Varnishes, Water and most Chemicals.

Ask for descriptive literature TODAY!

CAPITAL
ENGINEERING & MFG. CO.
5937 So. Ashland Ave.
Chicago 36, Illinois

Circle **23** on Reader Service Card

NEW PRODUCTS

ceptible to contamination. Free reverse flow in either energized or de-energized position. Parts are

hardened, ground, and lapped, with oil immersed plunger to assure long trouble-free operation.—*Fluid Power Accessories, Inc., Glenview, Ill.*

Circle **321** on Reader Service Card

ONE-HOLE MOUNTING SWITCHES

Specifications: Ruggedly constructed of corrosion-resistant stainless steel. Hermetic switch conforms to MS24331-1 listing; immersion test MIL-E-5272-1, procedure 1. Has 2 SPDT switches

with 6 terminals for multi-circuit control. Rated 4 amps at 28 vdc resistance; and 2 amps at 28 vdc resistance, 4-amp motor. Switches are backfilled with dry inert gas and tested to insure less than 1 micron-cu-ft per hr leakage.

Designation: H11-2.—*Control Switch Div., Controls Co. of America, Folcroft, Pa.*

Circle **322** on Reader Service Card

Circle **113** on Reader Service Card

SMALLER THAN A PLAYING CARD!

A HEAVY-DUTY PRESSURE SWITCH

with repeatability never before available in a piston-type switch. Functions properly every time . . . 10 times a second or once every six months.

SEND FOR CATALOG 41

Single and Duplex Models

50 to 5000 psi.

Explosion-Proof Models

Shock Resistant

Repeatability Range ±2 @ 50-100 psi. to ±50 @ 4000-5000 psi.

Standard and Close Differentials

For service with hydraulic fluids, liquids and gases.

OIL-DYNE, INC., 2115C W. Marquette Rd., Chicago 36, Ill.

MARSHALSEA

specialise in the manufacture of

Valves and Filters

for Hydraulic & Pneumatic Equipment

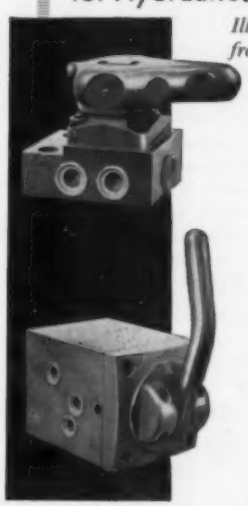


Illustration shows two examples from the wide range of valves

MBL.3128/1 (Top)

- 2-way selector valve feeds pressure to selected service (e.g. double-acting ram) leaving alternate selector position open to exhaust
- Selector handle in neutral position opens both selector connections to exhaust
- Other selector arrangements designed to customers' requirements

MBL.3405 *Prov. Pat. No. 34977/59* (Bottom)

- Single lever-operated valve actuates set of 4 chocks or single acting rams in pairs or sets of 4
- Separate selector valve incorporated to operate double-acting ram
- All operations, both pressure and exhaust, controlled by single selector lever
- 2 relief valves yielding at 6,500 p.s.i., fitted to valve body or installed separately
- Normal fluid — water and soluble oil

Full details gladly supplied on request.

MARSHALSEA BROS. LTD • TAUNTON • ENGLAND

An A.I.D. Approved Inspection Organisation

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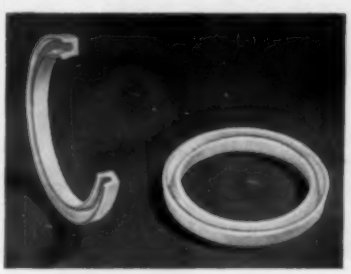
H·I·S

PRECISION TEFLON* "U" Cups FOR LOW FRICTION----- ---HIGH TEMPERATURE in any hydraulic fluid

Style 4505 "U" cups are accurately machined of virgin TEFLON to a special design developed by HALOGEN. 246 standard sizes are available without tooling charges.



Also available:

HALOGEN "V" RINGS

two types available for packed cylinders and other applications.

Write for literature . . . our new 12 page brochure on "U" cups is yours for the asking.

*DuPont T.M.

HALOGEN

INSULATOR & SEAL CORP.

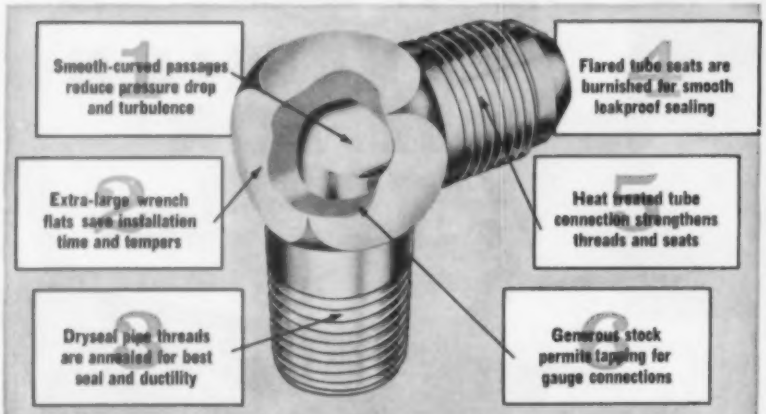
9960 Pacific Ave. • Franklin Park, Ill.

"Engineers and manufacturers— TEFLON Products"*

Circle **152** on Reader Service Card

Circle **89** on Reader Service Card

6 reasons for buying L&L hydraulic flared tube and pipe thread fittings


1
Smooth-curved passages reduce pressure drop and turbulence
2
Extra-large wrench flats save installation time and tempers
3
Dryseal pipe threads are annealed for best seal and ductility
4
Flared tube seats are burnished for smooth leakproof sealing
5
Heat treated tube connection strengthens threads and seats
6
Generous stock permits tapping for gauge connections

Because L & L brazes together standard machined bar stock components to make their fittings, you get more standard styles and sizes and faster service on specials.

L and L Manufacturing Company

21590 Hoover Road • Warren, Michigan

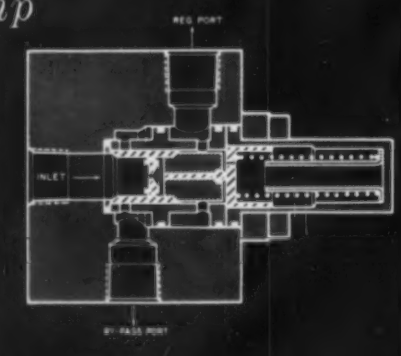
DISTRIBUTORS IN PRINCIPAL CITIES

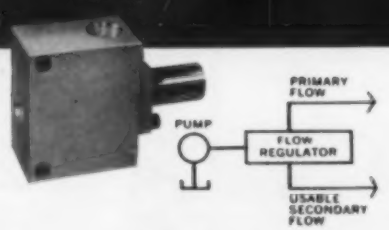
Provides Additional Circuits From One Pump

Flow Regulator

(NON-ADJUSTABLE)

- Constant primary flow regardless of pressures.
- By-Pass flow — useable at pressures independent of primary pressure





- Sizes — ¼" to 1" pipe (NPTF)
- Input flow to 60 gpm
- Primary flow to 40 gpm
- For oil to 3000 psi

Write for detailed literature.

Fluid Controls, inc.

Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

P. O. Box 186 • Mentor, Ohio • BL 5-3426

Circle **46** on Reader Service Card

NEW LITERATURE

Continued from page 60

LIMIT SWITCH

Combines compactness and sealed construction. Built-in indicating lamp tells whether circuit is being controlled. When switch is in non-operating position, current passing through a resistor lights a lamp behind special transluscent cover insert. When switch is operated, light goes off. Suitable where multiple switches are used, such as a packaging line or machine tool. Data sheet 185 gives technical information, dimensions, and ratings. —*Micro Switch, Freeport, Ill.*

Circle **412** on Reader Service Card

BALL VALVE

Valve doesn't jam, needs no maintenance. ¼ turn to open or close. Zero leakage in both directions without seat distortion. Teflon seats and seals. Pressures to 600 psig. Temperatures to 200 F. Sizes from ¼" to 2" NPT. Ports from 7/16" to 1½". Used in place of gates, globes, or plugs. Bulletin 712-361.—*Hydromatics, Inc., Bloomfield, N. J.*

Circle **413** on Reader Service Card

HYDRAULIC VARIABLE SPEED TRANSMISSIONS

Compact, totally enclosed, self-contained drives have 27:1 stepless variable speed range. Can pick up full load torque from zero rpm. Speed setting adjustments may be made with drive running or stationary. Incorporates torque-sharing, positive displacement, hydromechanical design. Transmits 10-hp output at 1400 rpm. Bulletin gives ratings, dimensions, and mounting information.—*Carter Gears Ltd., Yorkshire, England.*

Circle **414** on Reader Service Card

HEAVY DUTY HYDRAULIC CYLINDER

Single or double acting. Pressures from 2000 to 3000 psi. Bore sizes from 1½" to 12". Temperatures to 250 F. One piece piston fitted with two, step-cut rings, and

Continued on page 140

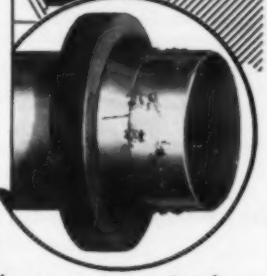
Circle **76** on Reader Service Card

YOUR BEST BET!

Seal-Guard®

THE ULTIMATE PROTECTION FOR VITAL HYDRAULIC PARTS

Two flexible, bronze, knife-edged wiper rings, mounted in a synthetic rubber cushion ring, throw all foreign matter clear of the rod.



Seal-Guard's unique metallic rod wipers are easy to install and self-adjusting. Their floating cushion absorbs side thrust, prevents scarring of the rod. Practically friction-less, they resist oil and heat for long, trouble-free service.

Standard sizes for ¼" to 6" diameter rods. May be special-ordered up to 24¼" in diameter.

HYDRAULIC ACCESSORIES CO.
24301 Hoover Road, Warren Mich.

NEW *Martin-Decker* **Precision Test Gauge** *makes pressure readings* **25% More Accurate**

8½" Dia. Dial — 25.13" Scale Length
12" Dia. Dial — 36.91" Scale Length

- **Big scale readings in small scale space!**
- **Greater Accuracy!**
- **Requires less panel space!**

360° Calibration makes Martin-Decker Scale 25% longer—gives 25% greater readability than models with 270° scale.

Ni-Span C Bourdon tube is temperature-stable, corrosion-resistant—superior to other alloys.

Tube tip bleed is standard equipment.

Movement calibrated to dial, with an accuracy of ± 0.15% or better.

Uniform linear increments. Protected front zero adjust.

Capacities from 60 PSI to 15,000 PSI.

Find out why more and more O.E.M. designers specify Martin-Decker Precision Test Gauges for measuring gas and fluid pressures.

MARTIN DECKER

Write for Technical Brochure T 137

Precision Pressure Instruments Testing—Weighing—Load and Force Measurement

MARTIN DECKER PRECISION TEST GAUGES

MARTIN-DECKER CORPORATION • 3431 Cherry Ave., Long Beach 7, Calif.

Circle **101** on Reader Service Card

STAFFA

HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTORS

Mark IV—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1—100 R.P.M. reversible). Overall efficiency 90%—95%.
Mark V—7 cylinder 6,600 lbs. ft. at 2,000 p.s.i. (Speed 1—75 R.P.M. reversible). Overall efficiency 90%—95%.
Ideal drive for conveyors, rolling mills, cranes, tractors, cement mixers, drills, and most mechanical handling applications.

4" HYDRAULIC BENDER

Standard equipment includes 2"—4" formers for steam and gas pipes. The machine can be supplied either **Hand Operated** or **Motorised** and accessories are available for ⅜"—1½" steam and gas pipes, flat bar bending up to 7" x ¾" section and electrical conduits up to 3".

A complete range of Hydraulic Pipe and Tube Benders ¼" to 18" dia. Pipes is available.

CHAMBERLAIN INDUSTRIES LTD.

Staffa Works, Argall Ave., Leyton, London, E.10, England.
Leytonstone 3678
(MEMBER OF THE CHAMBERLAIN GROUP OF COMPANIES)

American Distributors
Double A Products Company, Manchester, Michigan

Canadian Distributors
Affiliated Engineering Equipment Limited, 630, Cote de Liesse, Montreal

Circle **29** on Reader Service Card

At a cost comparable to an ordinary restrictor or needle valve, you can have pressure-compensated flow control in your hydraulic circuits.

Rated for pressures to 3000 p.s.i.

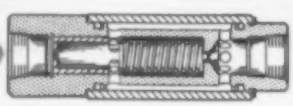
Wide range of sizes available—¼" to 1½" N.P.T.F. and ¼" to 1" S.A.E. tube.

Flows to 100 g.p.m. can be controlled.

Factory-calibrated and tested to ±10% tolerance. Closer tolerance available.

Require little more space than pipe or tube in which installed.

Trouble-free in operation—tens of thousands in use.



Unit senses pressure drop across precise orifice and reacts to control flow with desired limits.

Send today for new Catalog 1002.

W-8105

WATERMAN HYDRAULICS CORPORATION

725 Custer Ave., Evanston, Ill.

Circle **144** on Reader Service Card

NEW LITERATURE

two, V-cup type seals. Piston is pilot fitted to rod. Large ports can be rotated to any 90-deg position relative to each other and the mounting. Interchangeable needle valve and ball check retainer. Bulletin H-101 illustrates cylinder parts using a numbering system. Mounting data and dimensions given. Section shows accessories and special cylinders.—*Milwaukee Cylinder Co., Cudahy, Wisc.*

Circle **415** on Reader Service Card

MISSILE DEVELOPMENT FILM

Film tells story of company facilities and personnel and how they contribute to advanced product development for missiles and space craft. 18 minute, 16 mm, full color and sound.—*Pesco Products Div., Borg-Warner Corp., Bedford, Ohio.*

Circle **416** on Reader Service Card

PIPE FITTINGS, ADAPTERS

Describes all types of brass, steel, and stainless steel, pipe and straight thread fittings. Illustrates plugs, reducers, and connectors in thread sizes from ⅛" to 1¼" male and female. Lists O-rings for use in commonly used hydraulic fluid with mineral oil base, lubrication oil, and pneumatic and water service. Temperatures −40 to 250 F. Catalog 4360.—*Parker Fittings and Hose Div., Parker-Hannifin Corp., Cleveland.*

Circle **417** on Reader Service Card

AIR CYLINDERS

Dimensionally interchangeable. Bore sizes from 1¼" to 14". Temperatures from −40 F to 250 F. Pressures to 250 psi. Cushioning is done by trapping air between piston and cylinder head, then allowing it to escape at a predetermined rate. One piece piston. Modified U-cup piston packing can be replaced without removing piston from rod. Brochure has charts and tables for sizes and mounting information. Shows accessories.—*The Sheffer Corp., Cincinnati, Ohio.*

Circle **418** on Reader Service Card

IN-LINE FILTER CHAMBERS

Designed for filtering liquids to microscopic clarity at pressures to 100 psi. Remove dirt, oil, and water from air or compressed gases. Capacities for light fluids from 2 to 90 gpm. For heavy fluids from 1 to 45 gpm. Inlet and outlet ports ¼", ⅜", ½", and ¾" NPT. Heights from 9" to 41". All stainless steel 316. Bulletin 402.—*Sethco Mfg. Corp., Merrick, N. Y.*

Circle **419** on Reader Service Card

HYDRAULIC PUMPING SYSTEMS

Open power and closed power oil pumping systems are described. Open power systems include fixed-casing, free pump, free pump-parallel, and free pump-casing installations. Closed power includes fixed-insert, fixed-casing closed power, free pump-parallel closed power, and free pump-casing closed power. Pump selection tables are given. Sub-surface and well head equipment listed including 4-way valves and lubricators. Power equipment is specified, pumps to 5000 psi. Control equipment sections shows regulators, valves, gauges, and accessories.—*Kobe, Inc., Huntington Park, Calif.*

Circle **420** on Reader Service Card

MANUAL & PNEUMATIC BALL VALVES

Provide flow characteristics of gate valve, tight shut-off of globe valve, and quick quarter-turn of plug valve. No metal-to-metal contact. Mating surfaces between ball and seats are smooth, no lubricant required. Two-way shutoff, no leakage if flow is reversed for any reason. Temperatures from −150 to 600 F. Pressures to 1000 psig. Sizes from ⅛" to 12". Catalog 1200 details two basic valves: McCannaseal top-entry valve which can be repaired in the line, and McCannaflo valve with one-piece, bar stock body and end adapters.—*Hills-McCanna Co., Carpentersville, Ill.*

Circle **421** on Reader Service Card

AIR VALVES, CYLINDERS

Booklet covers 500-psi miniature bore cylinders, single or double acting, sizes from ⅜" to 2½".

Continued on page 142

Circle **36** on Reader Service Card

Model ES4-KM2 ½ actual size

ONE-WAY IMPULSE SWITCH

simplifies sequencing circuits

- ★ Eliminates Interlocking Switches and Complicated Actuating Dogs
- ★ Exclusive one-way actuator sends electrical pulse when depressed, then opens circuit. No pulse on actuator return.
- ★ Gives More Dependable Operation — replaces complicated controls
- ★ Lowers Cost of Control Circuits— fewer switches required
- ★ Faster Automatic Operation — closer sequencing possible

10 amps, 125v AC

Four models available with pulsing strokes from 1/16" to 3/8".

Described in Data Sheet ESC-7

$10.50 plus 25c shipping. Write for Quantity Discounts

CONTROLS COMPANY OF AMERICA

CONTROL SWITCH DIVISION

4224 W. Lake St., Chicago 24, Ill. • VAn Buren 6-3100 • TWX CG-1400

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.

CLOSURES

To Protect Threads, Tubes, Valves, Components, etc. from Dirt and Mishandling

Available from Stock

ALUMINUM		POLYETHYLENE	
Pipe Caps	"C" Series AN & SAE Fittings.	"200" Series Tapered Plug & Cap	"LT" Series Tube Caps
Pipe Plugs	"P" Series AN & SAE Fittings	"TY" Series Thick Wide Flange Tapered Plug & Cap	"600" Series Single Thread Pipe Caps
"D. O. C." Series Drive-on Caps	"C-FT" Series to all Thread Specifications	"EP" and "EE" Series Elec. Conn. Plugs & Caps	"TC" Series Self-Sealing Caps—for AN & SAE Fittings
"D.I.P." Series Drive-in Plugs	"ERA" Series for ERMETO and MS Fittings	"IF" Series Plugs for Inverted Flare Fittings	"SP" Series Flange Caps

Special Closures Manufactured to Customers' Specifications, of Aluminum or Polyethylene. Quotations on request, furnish description desired including thread size.

Manufacturers of Closures Since 1944

CLOVER INDUSTRIES, INC. 577 Young Street Tonawanda, N. Y.

Circle **34** on Reader Service Card

Safe-Q-Lube and Loadless starting

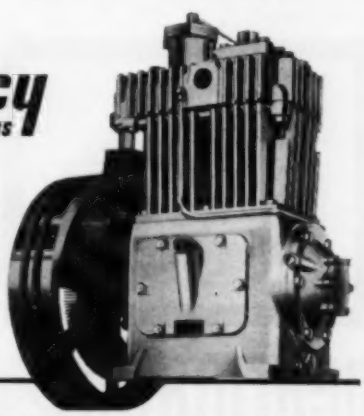
2 good reasons to think about Quincy

First, there's Quincy's exclusive Safe-Q-Lube pressure lubrication system which automatically unloads the compressor if oil pressure drops. No chance of damage to bearings. Secondly, patented Loadless Starting keeps the compressor unloaded until the motor reaches full speed. Stops are free-rolling, too.

Other Quincy features

- Cushioned Steel Valves
- Timken Bearings
- Lynite Connecting Rods
- Variable Differential Unloader
- Finned Copper Tube Intercooler

Quincy COMPRESSORS



CHECK THE 1960 "Q-LINE" NOW — a complete range of compressor models for all types of industrial applications.

QUINCY COMPRESSOR CO., Quincy, Illinois

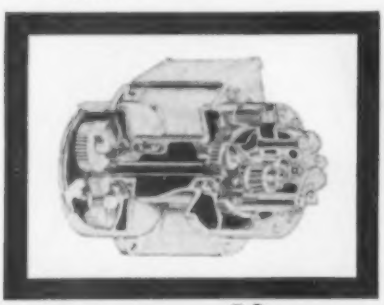
Makers of the World's Finest Air Compressors

Circle **121** on Reader Service Card

GEARMATIC
HYDRAULIC WINCHES

- Fully-hydraulic proven design
- Line pull capacities 6000-22,000 lbs.
- Simple, single-valve control
- Automatic pressure-actuated brake

Gearmatic's sensational new hydraulic winches . . . models 6, 11 and 22 . . . reverse at 0 to 5.25 times forward speed, unloaded or under load. Automatic reversing is also available. Write for Bulletin H-860.



gearmatic
COMPANY LTD.
7400-132 Street, North Surrey, B.C., Canada
GHCD-61

Circle **55** on Reader Service Card

NEW LITERATURE

Valve-cylinder combinations with 1", 1⅛", 1½", and 2" bore sizes. 2500-psi heavy duty cylinders, sizes 1" to 4". Includes pin-operated double acting and clamp cylinders. 2-, 3-, and 4-way valves to 500 psi, sizes ¼" to 3". 1500-psi miniature valves in sizes ⅛", ¼", and ⅜". Also air-operated pumps, solenoid-actuated, positive displacement, to 19.9 cc. Bulletin 91051.—*Airmatic Valve, Inc., Cleveland.*

Circle **422** on Reader Service Card

DIRECTIONAL CONTROL VALVES

Catalog covers 2-, 3-, and 4-way valves for pressures to 3000 psi. Metal-to-metal seals are spring and pressure loaded for positive sealing. Sizes ¼", ⅜", ½". Section specifies Spherotor 2-, 3-, and 4-way valves with rotary actuator. 100-psi air pressure gives torque to index Spherotor at 2000-psi hydraulic pressure through main valve. Describes gauge isolator and 3-way valve for panel, bracket, and sub plate mountings. Pressures to 5000 psi. Unit prevents gauge damage from pressure surges in all hydraulic circuits.—*Sarasota Precision Products, Inc., Sarasota, Florida.*

Circle **423** on Reader Service Card

HOSE ASSEMBLIES

Used as a quick guide to hose assembly numbers. Bulletin IEB-53 charts end fittings (JIC, SAE, etc) for low, medium and high pressure hose assemblies. Includes Teflon assemblies. Shows hose types used with each type of fitting.—*Aeroquip Corp., Jackson, Mich.*

Circle **424** on Reader Service Card

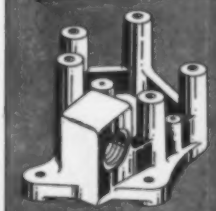
CYLINDER MOUNTING ACCESSORIES

Quick identification of mounting accessories for square-type, industrial hydraulic and pneumatic

Continued on page 144

HEISE GAUGES

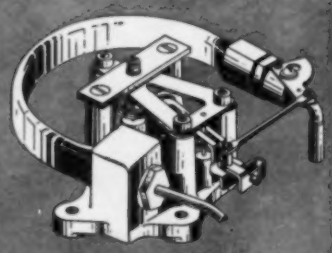
Minimize Recalibration Costs



Laboratory installations using Standard Inspection Control systems most frequently specify the rugged dependability of Heise Gauges to reduce inspection and recalibration frequency.

Calibration error resulting from minor displacement of the structural members of commercial gauge movements is entirely eliminated by the "integral" design of the Heise Gauge.

The universal acceptance of the Heise Gauge as a test standard for pressure sensing instruments is a continuing evidence of its performance as



THE STANDARD OF THE WORLD
HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

Circle **70** on Reader Service Card

Circle **5** on Reader Service Card

new ROTORAM® VALVES

WITH EXCLUSIVE ROTATING STEM

for MILLIONS of TROUBLE-FREE ACTUATIONS

Treadle Valve

Knob Valve

- Low silhouette mounting
- 2024 T4 aluminum bar stock
- Rust-resistant
- Full flow air passages
- Piped exhaust ports
- Interchangeable parts
- Anodized finish

Cam Valve

Finger Valve

Pedal Valve

Hand Ball Valve

Rotoram Valves are available in 3 and 4-way models for ⅛", ¼", ⅜" and ½" pipe sizes. Special Block "V" Packing permits free ram movement, insures long valve life. Port entry from either left or right side. Ask your AIR-MITE Distributor, or write for complete details and illustrated catalog.

AIR-MITE DEVICES, INC.

4401 W. Kinzie St., Chicago 24, Ill.

Kep-O-seal®

RUGGED! DEPENDABLE! CHECK VALVES with the Flexible Seal Seat*

- LEAK TIGHT! BUBBLE TIGHT!
- SURGE PROTECTED!
- FLOW—STRAIGHT THROUGH!
- LONG LIFE! EASY CLEANING!
- SIMPLE AND TROUBLE FREE!

The sturdy Kep-O-seal check valve can really take hard service. Conservatively rated, it absorbs severe shock from either direction and always holds its seal. *REMAINS LEAK TIGHT!* Has been proved outstanding in everything from machine tools to missiles! Investigate and see for yourself! Write for full details.

*Patent Applied For

KEPNER

KEPNER PRODUCTS COMPANY

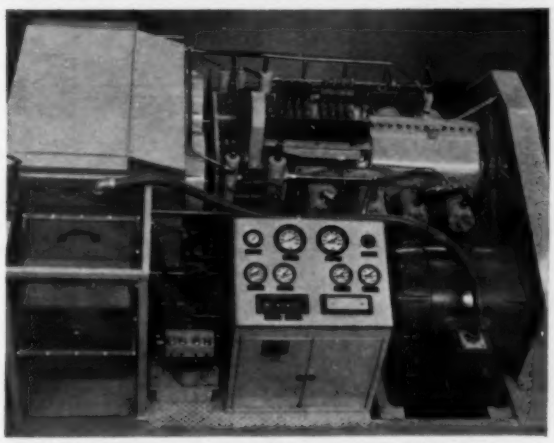
7321 West 59th Street • Summit, Illinois

Circle **87** on Reader Service Card

When You Need

HIGH PRESSURE HIGH CAPACITY, HIGH PURITY AIR, HELIUM NITROGEN

FOR COMPONENTS TESTING OR PRODUCTION



MODEL DPB-CCS Four-stage, 8-cylinder compressor. System includes full dehydration and oil removal, filter and complete control panel. Backed by Cardair's 20 years of high pressure gas experience. The only ICBM type compressor qualified by 2500 hour life test.

CCC CARDAIR CENTRAL COMPRESSION SYSTEMS

Guarantee Delivery

- up to 12,000 psi continuous
- with less than 1 ppm oil content
- 150 SCFM @ 128 psig intake • dewpoint −100°F.

Developed and qualified as GSE equipment for ICBM program—now available from stock or programmed production!

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For either testing or production, it may also be used as a central high pressure source for diverse locations, with Cardair supplying the complete system.

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NEW LITERATURE

power cylinders. Covers female rod clevis, female rod eye, clevis bracket, mounting plate and pivot pin. If cylinder bore and rod thread sizes are known, accessories can be easily selected. All key dimensions provided.—*Hannifin Co., a div. of Parker-Hannifin Corp., Des Plaines, Ill.*

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ADJUSTABLE PRESSURE SWITCHES

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Featuring rotary design, these units give pulseless positive air displacement. A rotor and sliding vanes are only moving parts. Centrifugal force holds vanes tightly against housing for efficient seal. Vanes are self-seating, self-adjusting. Automatic oiling system has visible oil supply with automatic shut-off when pump is idle. Shaft seal is automatic, needs no packing or adjustment. Rotary air motors described are from 1/20 to 7 hp. Speeds can be varied from 300 to 2000 rpm. Operates on 30 to 100-psi air. Describes compressors from .6 to 45 cfm, 30 psig; and vacuum pumps from .6 to 50 cfm, 28" Hg. 42-page catalog gives specs, drawings and performance charts. Included is an application ideas section. Also shown are oil-less compressors and vacuum pumps, and accessories. Request on company letterhead from Gast Manufacturing Corp., 23138 Highway M-139, Benton Harbor, Mich.

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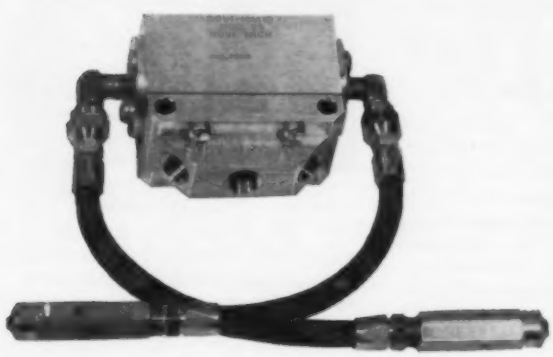

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Novi Tool & Machine Co. Novi, Mich

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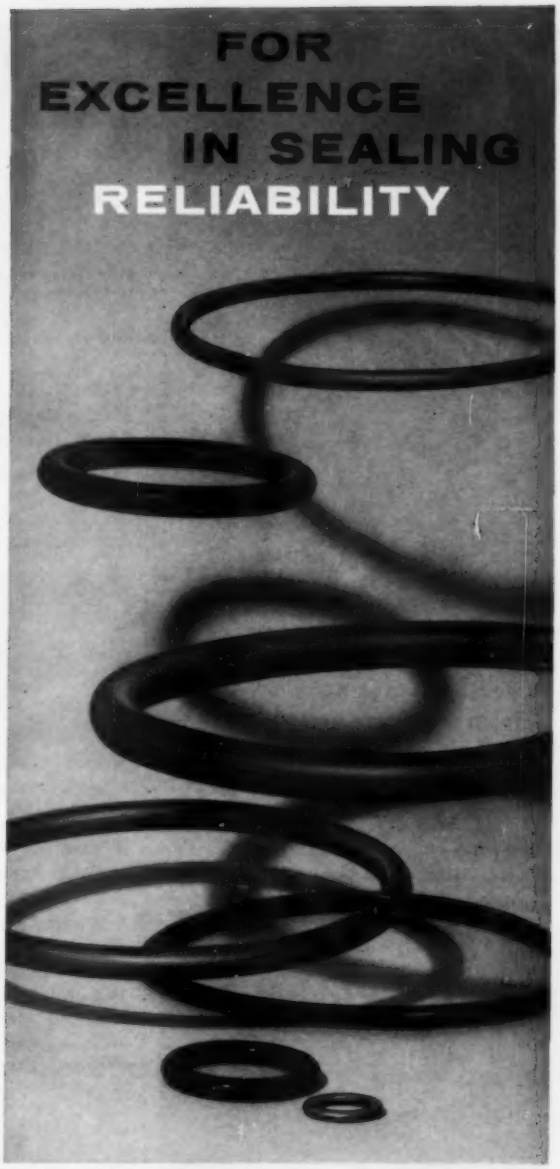

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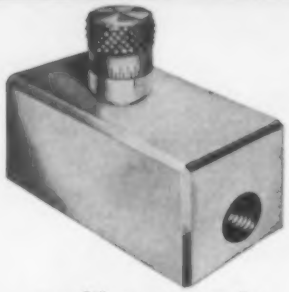

sensitive • accurate
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Available with ¼" to 1" ports, pressure ranges up to 5000 psi, with or without micrometer adjustment, and with male or female dry seal pipe-threads. Meet all J.I.C. and AN Specifications.

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POW-R-TROL
HYDRAULIC CHECKING UNITS

for positive motion control . . .

Circle 118 on Reader Service Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Modernair promotes Baum and Brandenberg

Karl Brandenberg has been appointed chief engineer of Modernair Corp., San Leandro, Calif. Brandenberg has been a pneumatic engineer in Switzerland. He is credited with various patents and has written books on pneumatics.

Brandenberg

Baum

Walter J. Baum, has been appointed assistant sales manager. Baum joined Modernair in 1960 as manager of the Industrial Products Div. His new assignment will include sales, service, and training requirements of Modernair's national dealer organization.

Oilgear appoints new vice president

Wiedmann

Ernst Wiedmann, recently appointed director of engineering by The Oilgear Co., Milwaukee, has been elevated to vice president and director of engineering. Wiedmann joined Oilgear in 1926. His career has paralleled the growth of the company. In 1932 he became assistant chief engineer, and chief engineer in 1935. He is on the executive committee of the National Conference on Industrial Hydraulics and serves on the board of the National Fluid Power Association.

New appointments at Arrow

F. A. Emmons has been appointed general manager of Fluid Power Div. of Arrow Tools, Inc., Chicago. Also H. R. Schlagel was appointed production manager, and J. R. Brown sales manager.

Company gets new chairman, new name

Machinery & Machine Supplies Co., Inc., N. Y., has been renamed Loewy Machinery Supplies Co., Inc. At the same time Alfred Loewy has been elected Chairman of the board of directors and chief executive officer. The firm distributes and manufactures hydraulic and pneumatic components and equipment.

Dynex promotes general manager

Orvis

I. Dudley Orvis has been promoted to vice president of Dynex, Inc., Pewaukee, Wisc. Orvis will continue as general manager responsible for the operation of Dynex. He has been with the company since 1956, and served as manager of manufacturing engineering, administrative assistant to the president, and general manager.

Gast opens new pneumatics laboratory

Gast Mfg. Co., Benton Harbor, Mich., has opened new lab facilities for research and development, testing, and trouble-shooting. The lab contains a compressed air system with .25% accuracy. Pressures range to 100 psig, at 1000

cfm. Included are automatic recording instruments for temperature, pressure, vacuum, flow, torque, horsepower, and speed. The products handled in the lab are rotary air motors, air compressors, and vacuum pumps.

Schrader names assistant industrial sales manager

Doty

Lawrence R. Doty has been promoted to assistant industrial sales manager for A. Schrader's Son, Div. of Scovill Mfg. Co., Inc., Brooklyn. For the past two years, Doty has been industrial sales promotion manager for Schrader, and before that, southeastern field engineer. Before joining the company, he held posts in the New York branch of Electriglas Corp., General Steel Products, and Otarion, Inc.

Sturgis opens branch office

Sturgis Equipment Co., St. Louis, recently opened a branch office in Kansas City. The branch offers complete inventory and service on Sturgis' principal lines. Sturgis covers Kansas and western Missouri for Hansen Mfg. Co., Racine Hydraulics & Machinery, Inc., Mechanical Air Controls, Inc., and Hydro-Line Mfg. Co.

Ralph B. Latham is territorial sales representative. He has been with the company four years. William Glendening is sales correspondent and order department manager.

Davey Compressor appoints sales manager

Greene

Davey Compressor Co., Kent, Ohio, has appointed James A. Greene as regional sales manager. Greene has been with Davey for 14 years. His jobs have been test engineer, service engineer, and field service representative. In his new post, he will direct sales and service in Ohio and Pittsburgh on industrial compressors of 2 to 150 hp.

Continued on next page

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The Fall "CJ"* Wiper-Scraper Ring is Spring-Loaded causing Squeeze-Grip Action on the O.D. of the piston rod during entire cycle. This patented feature maintains a uniform, continuous pressure on the wiping edge of the ring at all times, stopping any buildup of foreign matter between the ring and the rod.

It automatically takes up wear, maintaining NEW RING PERFORMANCE. Available in diameters ½" through 13" for any commercial use. AN and MS numbers in use by the Military and Aviation industry since 1944. Manufactured in accordance with MIL-S-5049. (*Closed Joint)

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POST SCRIPTS OF INDUSTRY

Parker-Hannifin adds three sales engineers

Fred D. Zikas has been added to the Detroit sales office of Parker-Hannifin Corp., Cleveland. Dennis Sullivan will go to Parker-Hannifin's Chicago office. John W. Chamberlain, joining the Cleveland office, has been assigned to work in Toledo. The three men will handle industrial pneumatic and hydraulic products including power cylinders and air control valves, air system lubricators, filters and regulators, tube and hose fittings and accumulators.

New distributors

Cummins Diesel of Northern Ohio Inc., Cleveland, will distribute industrial hose and reusable fittings made by Parker Fittings & Hose Div., Cleveland. Lloyd Sharp will head this hose program for Cummins. W. E. Anderson will lend technical help.

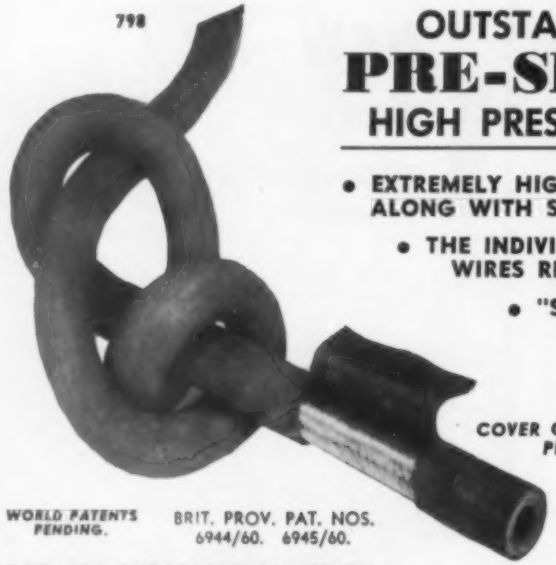
TEC Engineering Corp., Logansport, Indiana, has been appointed factory representative in Indiana for S-P Mfg. Corp., Cleveland. They will handle standard and heavy duty air and hydraulic cylinders, rotating cylinders, valves and accessories; and air-oil boosters, TEC also has offices in Ft. Wayne, Indianapolis and Muncie.

Clippard Instrument Laboratory, Inc., Cincinnati, has appointed two new companies, *Airdraulics, Inc.*, Chattanooga, and *Air-Oil Products, Inc.*, Cleveland, as stocking distributors for Clippard miniature pneumatic products.

Zurn Industries, Inc., Erie, Pa. has appointed *Hako-Hearn Engineers* as sales engineers for its Fluid Control Div. Hako-Hearn Engineers will call on pipeline strainer and accumulator users in Oklahoma and northwestern Texas.

Timer Service Co., Boston, will distribute air regulators, filters, and lubricators for Hannifin Co., a div. of Parker Hannifin Corp., Des Plaines, Ill. ▼▼▼

798



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- EXTREMELY HIGH PRESSURES ARE OBTAINED ALONG WITH SUPER-FLEXIBILITY.
- THE INDIVIDUALLY CONTROLLED HIGH TENSILE WIRES REMAIN INERT AFTER WRAPPING.
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- LONGER HOSE LIFE DUE TO LESS COVER FRICTION.

COVER CUT BACK TO SHOW PRECISE WRAP.

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An outstanding sales position is open for a Mechanical Engineer with a proven successful sales background in the application of industrial hydraulic and pneumatic components. Now in our 20th year as the West's largest independent distributor, we represent leading manufacturers of fluid power components. In six years we have grown from 45 to 140 employees. Our complete engineering and manufacturing facilities provide full support in experienced overall systems capabilities. Substantial salary and commission. Excellent Profit Sharing Plan and Insurance benefits. Financial assistance if relocation is required. Forward resume in strict confidence to Tom S. Cozzens, District Manager.

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Industrial hydraulic service and repair organization with good contacts, San Francisco Bay Area, interested in securing distributorship of quality hydraulic and allied lines. Replies will be held confidential. Reply Box No. 7261, HYDRAULICS & PNEUMATICS.

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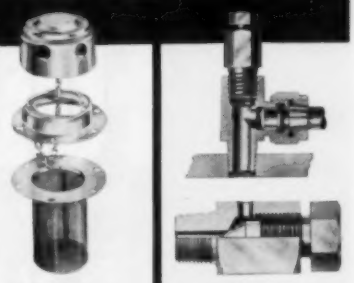

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HOW TO SELECT QUICK-CONNECT COUPLINGS . . . Nov., 1960
8 pages discussing the design factors which a user should consider in selecting a coupling. Sectional drawings of various designs.

WHAT YOU CAN GET IN ROTARY ACTUATORS . . . Aug., 1960
6 pages showing designs, operating specifications, and application ideas.

PLASTIC LINES—CAN THEY MEET YOUR FLUID POWER NEEDS? Apr., 1960
This report boils down the characteristics of various types of plastic tubing—the "do's" and "dont's" for successful applications.

DESIGNING MACHINE CONTROLS FOR AUTOMATIC ASSEMBLY . . . May, 1960
12 pages showing in detail how electrical and pneumatic components are ingeniously combined to speed up an assembly operation.

WHAT TO LOOK FOR IN AIR VALVES . . . Apr., 1959
16 pages describing and illustrating basic designs of directional, pressure, and flow control valves.

HOW FIRE-RESISTANT FLUIDS ARE USED TODAY; and PACKING MATERIAL FOR F/R FLUIDS . . . Nov., 1959
8-page report describing applications and characteristics of F/R fluids. Includes chart of packing materials for F/R fluids.

TEMPERATURE CONTROL IN HYDRAULIC SYSTEMS
16-page report on system design, fluids, packings. Components affecting temperature control.

ELECTRICAL CONTROLS FOR FLUID POWER SYSTEMS
8 pages of charted specifications for limit switches, timers, solenoids, and pressure switches.

A COURSE IN HYDRAULIC VALVES—Part I
Directional Control Valves, WHAT 3-POSITION AIR VALVES CAN DO Feb., 1961
Basic characteristics of spool, packed plunger, rotary, poppet, sliding plate valves. Air valves article discusses center porting of 3-position valves. 12 pages.

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NEW! Pneu-trol® QUICK EXHAUST VALVE

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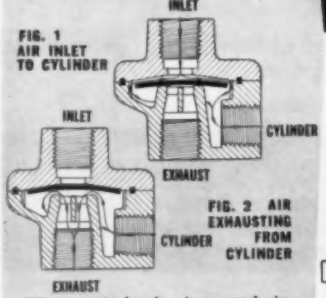
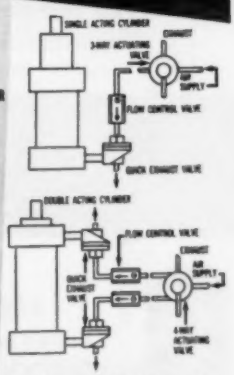


When control valve is opened air pressure seals exhaust port and diaphragm is deflected permitting air to pass thru the cylinder port (Fig. 1). When inlet pressure is relieved (by actuating valve in control circuit) the buildup of cylinder return pressure closes inlet port (Fig. 2) snapping the diaphragm off the exhaust port allowing instantaneous evacuation of exhaust air. *Write for complete details, specifications and prices.*



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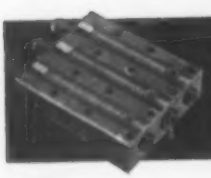

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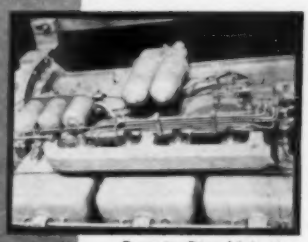

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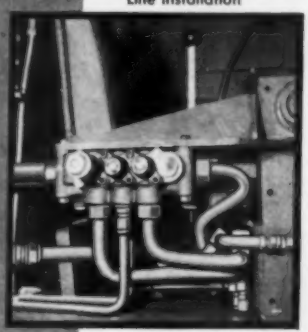

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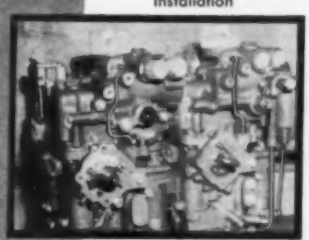

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